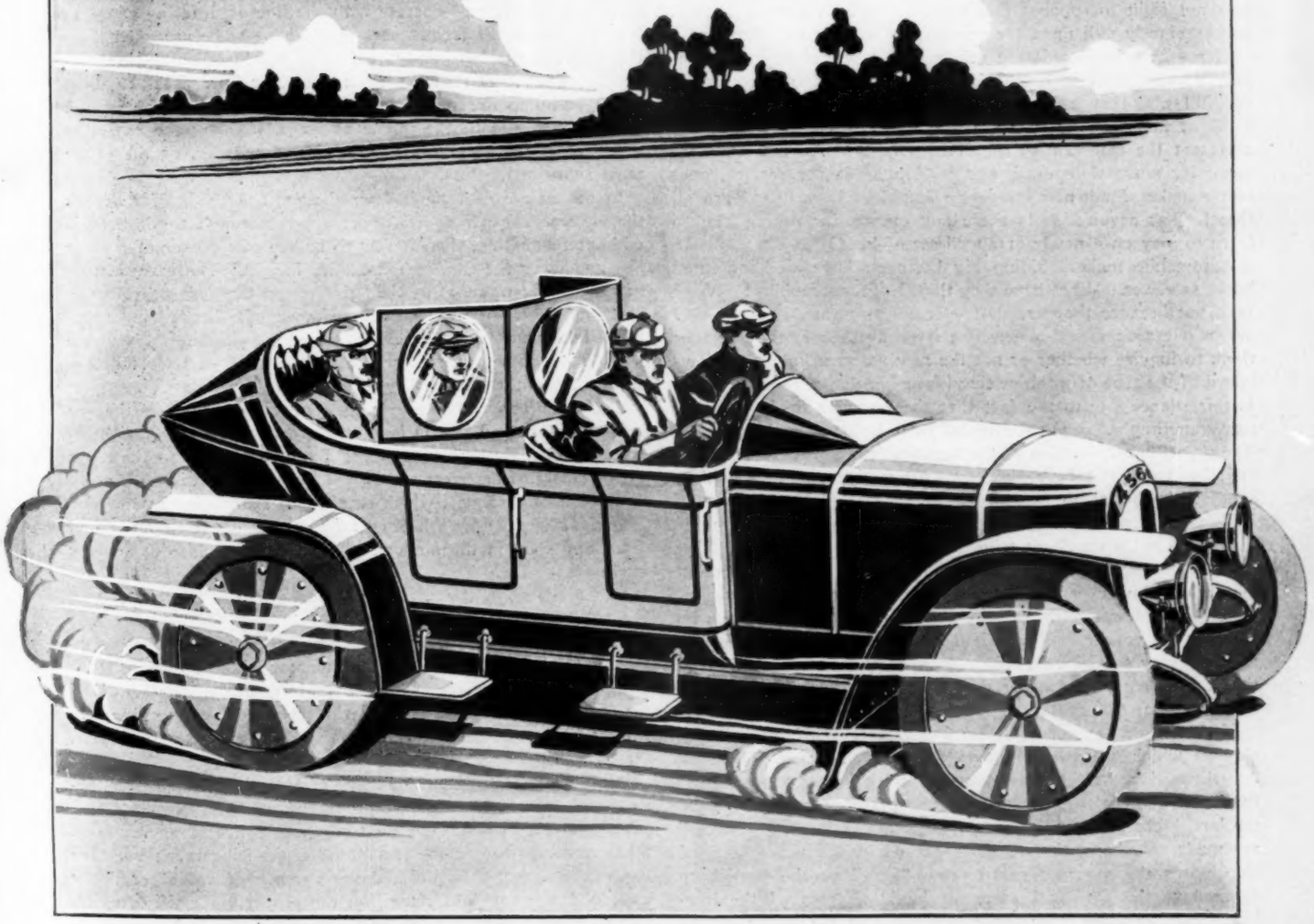
VOL. XXIII NEW YORK—THURSDAY, JULY 28, 1910—CHICAGO No. 4

THE AUTOMOBILE

STANDARDIZATION IS THE NEED OF THE HOUR



STANDARDIZATION is the goal to which the automobile is traveling. The journey is a long one. Headway is beset by impediments at every hand, and, unfortunately, this giant benefactor of every art, with the silence of winged time, passes up and down the highway of progress, bowing to all who have lifted the veil of ignorance, unseen, however, by the scattered mob.

If it is admitted that a steering wheel should be fitted with a gear that will require a certain angular displacement in order to cant the front road wheels from the straight-ahead position to the angle of locking, and granting that this condition is not adhered to in every automobile made, viewing the whole situation in perspective, does it not represent incoherence of design?

Memory permitting, ancestry is lauded; the fair pages of history are scanned for a glimpse of a situation which reflects honor

upon the individual and nations of individuals. As in a looking-glass, man contemplates the past, hoping, perchance, that grandfather carried a gun or spiked a cannon in a bygone fray. Discovering that glory of history casts its beam upon the family tree, the members thereof shoulder the burden of standardization as it is thus emanated.

Darwin traced the ancestry of man back to the time when he hung by his tail to the limb of a tree. This brave ancestor pushed ahead to go ahead, pushed to the right to go right, pushed to the left to go left, pushed to the rear to go back, and held back to stop. If the fair pages of history are to serve as the mirror to guide the faltering steps, is there any justification for gazing at that part of the mirror which discloses the "spiker of a gun" to the exclusion of the other precedents?

Habit is strong; it is the product of two schools. Nature is the "Master" of one, and man acquires the other by directly imbibing. If a yellow streak can be transmitted for seven generations, allowing that Nature does not discriminate, is it not also true that man naturally performs certain acts in the certain ways that were handed down from the dusty pages of the past? If so, is it not right to suppose that the driver of an automobile will subconsciously pull upon the emergency brakes to stop a car?

Piano-forte keyboards are universal. A musician from Hungary who sojourns in Bombay approaches the piano there, knowing full well that it is similar to the one in his own drawing room at home. Why should it be any different? Does it not represent the embodiment of all experience? An autoist, after using his automobile until it is no longer fit for service, goes to the maker for a new one; why should he have to unlearn all that he has acquired? Is there any excuse for asking him to learn to play on a newly arranged set of keys?

Automobile makers, doing big business, have well-appointed business offices. What have they there? Stenographers! Why? Is it not because they are deft, efficient, accurate, and reliable? When one retires, and a new one is engaged, does the manager think to inquire whether or not the new aspirant knows the keyboard of the type of machine that is used in that particular office? Is this silence due to the fact that the manager thinks that the new stenographer is so experienced as to know everything? No. The great "head" is alive to the fact that the keyboard is standard; he would not have purchased a machine excepting with a standard keyboard.

Ships that sail the "high seas," that make the "Grand Round" in a year and a day, that take departure with a full crew, that could not possibly survive a single storm of magnitude without men who know every rope in the whole make-up, rarely complete the homeward voyage with the men in the folks-hold who ship for the voyage. Why is it that a ship can sail from Liverpool, journey to Calcutta, lose a man overboard, replace him at the port of entry, and never give a thought as to the capability of the seaman?

Similarity of arrangement and fixed locations of the belaying pins to which the seamen make fast the clewlines, leechlines, bunt lines, fore braces, main braces, mizzen braces, staysail halliards, jib halliards, and the numerous other gear which puzzle the land-lubber, are at the bottom of it all. When the "braces" are made shipshape, the ensign is dipped in salute as the good ship noses the narrows passing the "fort," as the yards are squared to the passing breeze, as the inhabitants of the low-land hear but faintly the mellowed sound as the officer of the watch in bold confidence gives commands in quick succession: "Haul around the crossjack yard! Hard down the wheel!" As the gamut is run, as the ship responds to the trim of the sails, as the seamen bend with alacrity, is there any sign of confusion, any indication of uncertainty? No. Why? Standardization!

Come, let us join the fashionable audience at the Metropolitan Opera. It is a gala night. Gathered from the capitals of nations, there to entrance with art, are the prime donne and a galaxy. The text of the opera is but a detail, and the plot is scarcely noticed. It is the silver tongue, the song of the oriole, and the blandishment of the thrush that casts a spell o'er the audience. The mingling of the thousand-voiced chorus brings bliss to the refined ear, and when the situation is properly explained, it will be numbered among the normal expectations, the fact that little effort was demanded of the great impresario to weld this aggregation from separate units, gathered from many lands, into a homogeneous unit. What is the secret? Standardization—all the voices are pitched to the "International" key.

Railroads Were Standardized After a Long Struggle

It is well within the memory of the present generation when railroads were on the same more or less heterogeneous basis as now confronts the users of automobiles. The gauge of trackage varied from 21 1-2 inches to 3 feet 3 3-8 inches, and upwards to 4 feet 8 1-2 inches, stopping at 60 inches, excepting in one or two isolated cases. It requires no stretch of the imagination to arrive at the conclusion that a freight car built to travel on a 4-foot 8 1-2-inch gauge track would have to stop going at the end of its own line. A connecting line with a meter gauge (3 feet 3 3-8 inches) could only co-operate with the line of differing gauge to the extent that the freight cars would have to be unloaded from the meter-gauge line, and the freight would have to be transferred to the cars standing upon the other line. This handling and rehandling of freight resulted in a loss to the roads, and ultimately a loss to the public at large, it being the case that quasi-public institutions must thrive and prosper, or the public must share in the loss.

In the course of time it dawned upon the heads of railroads that it was cheaper to transport goods through to destination without rehandling, than it was to be the sole owner of a short line and incur the cost of rehandling freight. The early history of railroading was that of the "big frog in the little pond." The history, in fine, of the character of men who headed these disjointed railroads was that of efforts which ultimately led to the writing of an epitaph, always of the men, but, unfortunately, frequently of the efforts they misdirected.

The time arrived in the history of railroads when the car builders assembled in conclave and contrived what is known as the M. C. B. (Master Car Builders' Specifications). As the result of the labors of the great minds which undertook this work every dimension of each part which enters into railroading in any way is standardized, and a wheel or an axle or what not may be had from any shop in the land and it will fit into place in any car made.

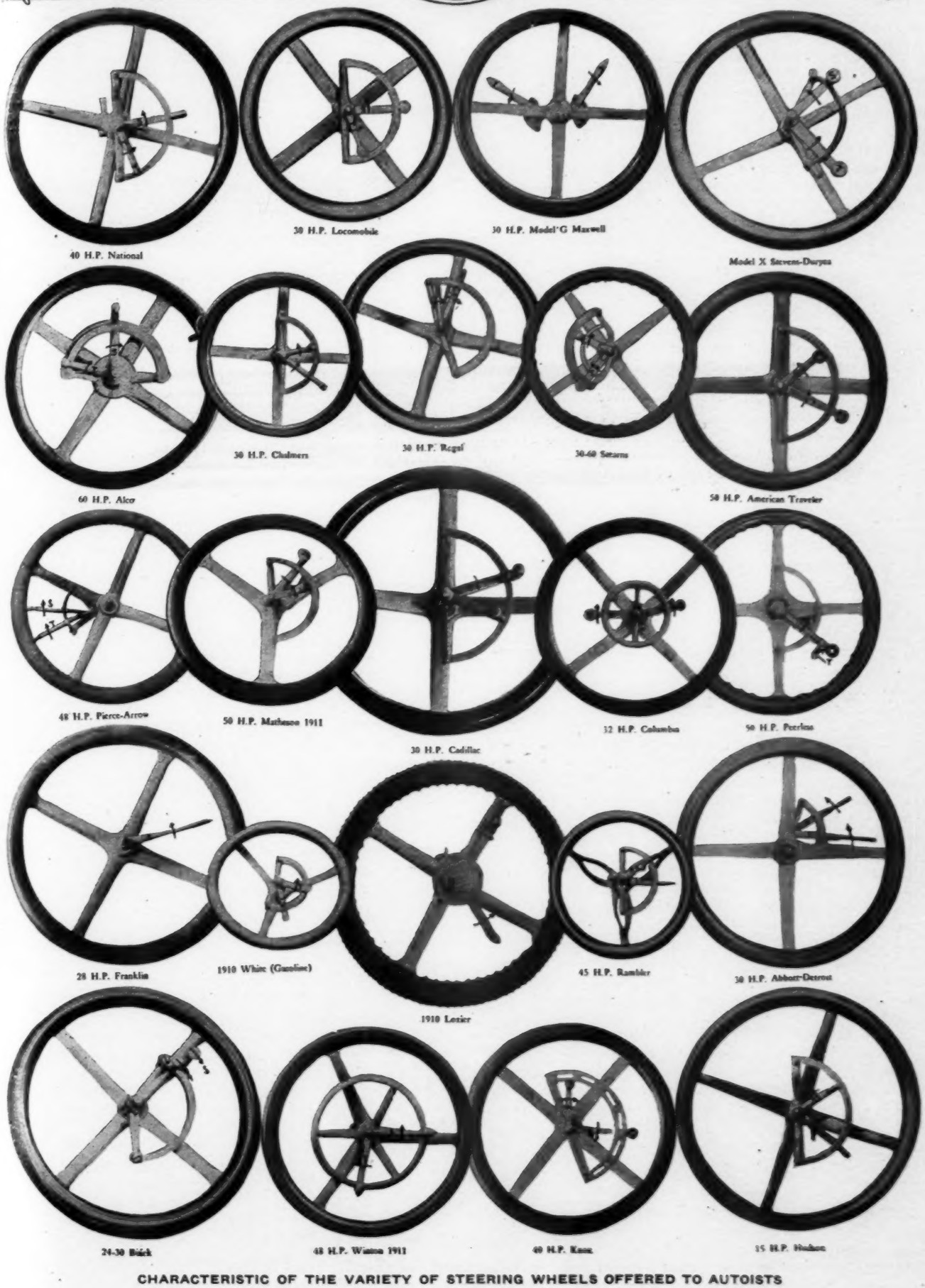
Standardization Is the Next Mile-Stone Ahead

Every industry traverses the road called progress; it has its inception in the fertile brain of the inventor whose ability to think twice in the same direction is always in question. The breath of commercialism instills life in the invention, emanating from the infected thorax of the "promoter," who, as a matter of course, "tries it on the dog."

With a sufficient amount of merit residing in the main idea, despite the imperfections of the promoter's method, invention survives, and art grows. The next step in the life of an invention takes its departure at the instant of capitalizing merit with the expectation of trading off a dollar's worth of value per dollar expended, figuring in a return on the property for the investor. It makes no difference whether the investor is he who furnishes the capital for the building of the device, or whether he is in the guise of a purchaser who expects to use the same and profit thereby.

Since it is true that the standardizing process has proven of unquestionable benefit in the arts thus far enumerated, it only remains to call attention to some of the advantages, applying them to the automobile, discussing them from the two points of view. Activity may now be noticed among makers and work which is being done by the Society of Automobile Engineers, with a

Midsummer S A E Meeting



CHARACTERISTIC OF THE VARIETY OF STEERING WHEELS OFFERED TO AUTOISTS

view to the standardization of the materials for use in the manufacture of cars.

Properly Classified Materials Represent First Requisite

Users of automobiles, with a limited vision, based wholly upon their own needs and influenced by the shortcomings of the cars they employ, reach the hasty conclusion that the question of standardization is no greater than the one they see. It is a gross injustice to the great problem involved to assume for a moment that a standardization product can be evolved from a mere aggregation of a kindred form of materials. It is first necessary to classify and standardize the materials which are to be used, and only then will it be feasible to place the stamp of standardization upon the finished product.

It may be taken for granted that the companies, severally and collectively, will find ways and means to cope with the standardization problem as it refers to the materials used, but it remains to be seen how the plans will be so unified that drivers of automobiles will not have to unlearn what they acquire with one car when they take up another and different make.

Habit Becomes an Asset to a Driver of a Car

When an aspiring autoist purchases his first car he assumes the position and prerogative of a juvenile in the primary grade at school, and he learns the A B C of the automobile. If it is a good school (automobile) the basis of his future education will be well founded, and as he progresses from grade to grade he will acquire habits which to him will be an asset for all the time to come, and he will thereafter subconsciously direct his efforts in precisely the right channel in every emergency, so that accidents, as the result of false moves, will scarcely be chargeable to him.

When the autoist graduates from this school (automobile) and he elects to transfer his affection to another, if there is no standard plan between them, the poor autoist will be in a most unfortunate position. Force of the habit, acquired under the conditions of his previous training, will be as a handicap to him in his every move. He will be in the position of the piano-forte artist who is suddenly confronted with a keyboard that is not built in accordance with the customary standard, and instead of moving under the force of acquired habit, effort will be conscious, more or less studied, but always retarded by subconscious influence as dictated by the habits previously acquired.

It is not the intention here, at this time, to offer any suggestion leading up to the struggle for unification of the control systems of automobiles. Perhaps the state of the art is not as yet such that the various makers of automobiles would be content to send delegates to a convention empowering them to agree upon a standard set of control units, such as might be written in indelible ink and hung up in front of every draftsman in every shop, telling him in precise language how every part should be made and the relations of parts, so that an autoist would be able to get into any car and drive away with the assurance to himself that the habits previously acquired in the process of driving other cars would stand him in good stead in the face of a new emergency.

It is not believed that all the accidents that we hear of from time to time are due to mistakes made by drivers, but it must be appreciated that well-drilled men are more capable of conducting themselves on a basis of precision of movement than is possible otherwise; but this thought leads up to the really serious situation, and it is worth repeating here: Drill a man to proficiency in one way and suddenly require him to act against the habit acquired and he will go wrong.

Present Situation as It Confronts the Autoist

For the purpose of showing that there is no approach to standardization in the cars as they are now made, the staff photographer of THE AUTOMOBILE called at the sales agencies of makers indiscriminately, and with few exceptions succeeded in taking photographs of the latest and most up-to-date cars from three points of view: (a) Showing the side levers, which include the emergency brake lever and the sliding gear lever; (b) the steering wheel with spark and throttle levers thereon; (c) the pedals, comprising clutch, service brake and accelerator control. In each case the direction of motion is shown by arrows, and it will be seen at a glance that there is a wide divergence between them, if indeed it may not be said that there are no two alike.

It would be the height of folly at this time to proclaim in favor of any of the methods illustrated. It is even a question if any coterie of men are mentally equipped to dispose of this broad and important matter on a basis of merit. In a sense, the worst one of the lot, as a standard for all, would have a masterly advantage over the present arrangement, and the chances are that a "compromise" is all that will ever be arrived at as a final disposition of this problem.

Just to indicate that it is not feasible for designers to make a "Chinese copy" of all the good points in the several examples of automobiles with a view to the production of one superlative car, it will suffice to say that this plan was brilliantly executed on a few occasions, but the mess of junk evolved failed to please those who were expected to support such a brilliantly conceived scheme. When a designer trades off his individuality for a mess of spineless pottage, his inharmonious aggregation ceases to find favor. One of the dangers encountered in the advocacy of a plan of standardization is represented in the influence against individuality, a price is put upon the head of the advanced designer, and the influence is against the highest obtainable average result. But the horizon, from the point of view of the standardization of the automobile, is no darker than it was when railway standards were brought to the fore. The men who will have to agree upon standards are no less capable than the master car builders of former days, but the necessity for action is possibly more acute than it was in connection with railways, one reason for which lies in the fact that railway trains were guided by bands of steel and railway locomotive drivers were men of skill, born of definite training. It is a far more serious matter to place an automobile at the disposal of a man of comparatively little training, and permit him to travel where he will, unrestrained by aught but his own inclination, and it is a self-evident fact that the risk can only be reduced to a minimum if the training which he receives at the start becomes the basis of habits which will stand him in good stead when the emergency arises.

Grading of Materials Rapidly Going On

When the Mechanical Branch of the A. L. A. M. was organized, it was then recognized that nothing could be profitably undertaken in the direction of the standardization of automobiles without having standardized materials to work up. The makers, in getting together and forming a mechanical branch, indicated in this act that many reforms were necessary, and they recognized the difficulties at every hand that beset the purchasing agents of the respective companies. Of the materials that demanded first attention, it is likely that steel was the most conspicuous, and it did not take long to find out that alloy steel, while it offered excellent possibilities, was not wholly to be relied upon in every emergency. When alloy steel first came out, and it found lodgment in many foreign automobiles, they, as they were used in America, proved to be most unreliable in many ways. Broken crankshafts were quite common, and observation did not have to be penetrating to allow of the conclusion that the harder grades of steel had limitations. The modulus of elasticity is probably no higher in alloy steel than it is in ordinary grades, and, when crankshafts are made of alloy steel, they have to be of the same diameter as though they are made of carbon steel. The price of alloy steel is six times higher, and it becomes a question as to whether or not it fills the bill under all conditions—the engineers of the companies, in meeting, settled this matter.

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PEDALS ARE WITHIN STRIKING DISTANCE OF A STANDARDIZED CONDITION

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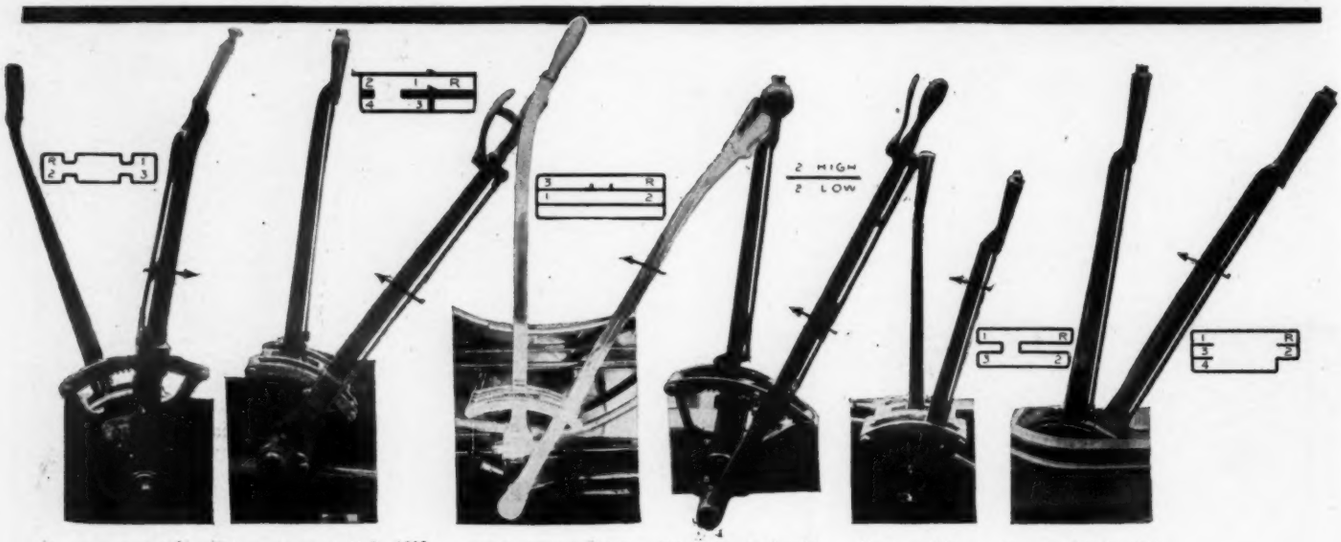


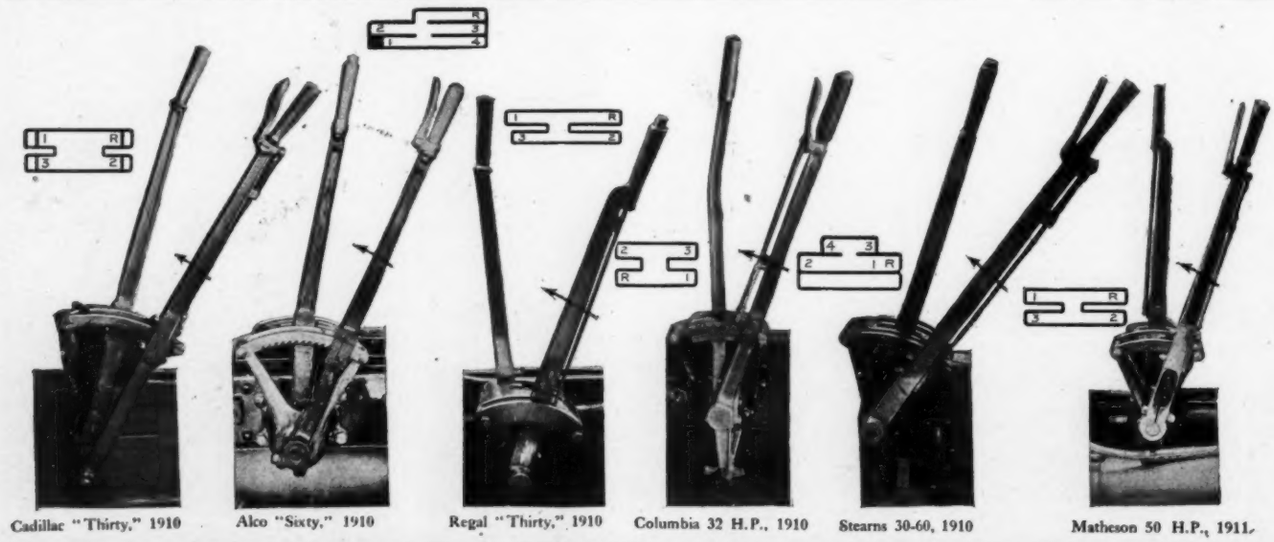
Rambler 45 H.P., 1910 Pierce-Arrow 48 H.P., 1910 Franklin 28 H.P., 1910 White (Gasoline), 1910 Hudson, 1910 Winton 48 H.P., 1911

DOUBTLESS the growth of the automobile industry in America represents a mode of procedure that has no precedent. Other arts, while they attain conspicuous proportions in time, do not compare favorably with the situation as it obtains with the automobile, which, in a decade, revolutionized methods of transportation. That merit is the basis of automobile success is never questioned, but it must be remembered that the vast amount of work done in the evolutionary process required an unusual array of facilities, and in the final sum-up from an historical point of view accessory makers must be given credit for a large proportion of the good work done.

The enormous output of automobiles comes from the combined efforts of the makers of cars and the makers of accessories. The acknowledged superlative quality of American automobiles is traced back to quantity production on a jig basis, favored by specialization at the hands of those who devote themselves to some one phase of the problem. As a general rule a machine reaches its highest state of perfection if all its components are made under the eye and direction of some one competent head, but when the undertaking passes beyond the domain of a single individual the same principle for success can only be perpetuated if the units of the machine are separated out and the influence of the specialist is brought to bear upon them respectively.

That the making of automobiles has passed beyond the point where any one man can know of all the things that are being done is a self-evident fact, but it is reasonable to accept the version that is presented by the advanced accessory maker in which the claim is made that the work is on a specialized basis and the details are executed under direct command or as the result of an intimate understanding.

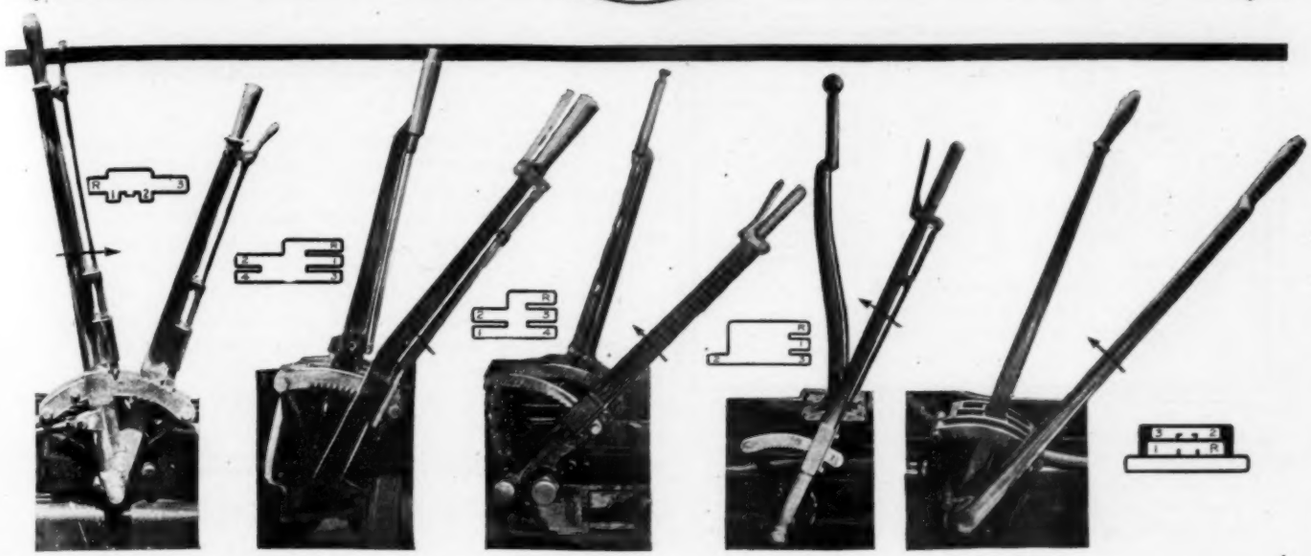
To what extent the output of automobile plants was increased by calling upon the accessory makers to anticipate is difficult to fix, but it is a fair claim that there is not a single make of automobile turned out that is entirely free of accessories of one kind or another. True, some makes of cars are almost completely produced in the makers' plants, but even they rely upon outside sources of supply for magnetos, tires, perhaps carbureters, and



Cadillac "Thirty," 1910 Alco "Sixty," 1910 Regal "Thirty," 1910 Columbia 32 H.P., 1910 Stearns 30-60, 1910 Matheson 50 H.P., 1911

SIDE-LEVERS ARE GREATEST OFFENDERS IN THE SCHEME OF STANDARDIZATION

Midsummer S.A.E. Meeting



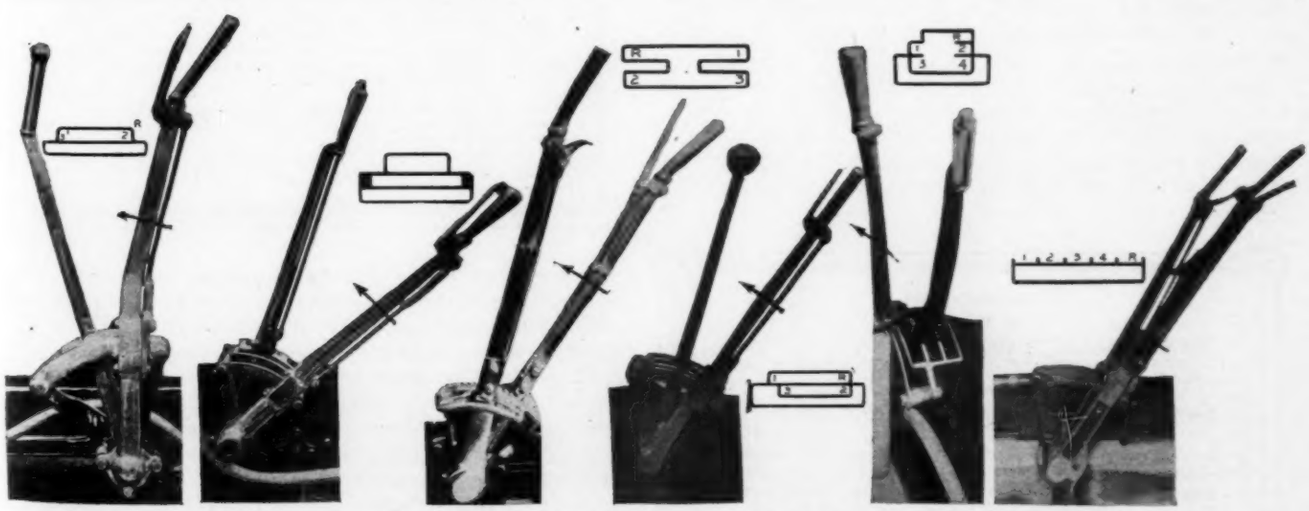
Stevens-Duryea, Model X, 1910 | Peerless 50 H.P., 1910 | Lozier, 1910 | Knox 40 H.P., 1910 | Buick 24-30, 1910

not infrequently bodies. Other manufacturers of automobiles resort to the co-operation of accessory makers on an increasing basis, and finally there are products which rank as mere assemblages in which accessory makers furnish the units and parts complete.

Not infrequently arguments are presented, mostly by those who have but a passing acquaintance with the intricacies of the situation, which have for their basis the idea that automobiles are perfect in proportion as they are built without the aid of the accessory plant. Obviously, the maker of an automobile gets what he pays for, and if he selects the highest grade of accessories for use on the type of car he puts out, the car will reflect the high quality of the accessories so produced. If, on the other hand, the car is not to be a good one, and the accessories are purchased because they are low-priced, they will no doubt conform to the requirement.

In the process of standardization accessory makers are doing more perhaps than they are given credit for. As an illustration of the influence of the accessory maker on standardization, it is only necessary to call attention to the fact that in so far as some one make of live rear axle is adopted by 10, 20, 30 or 50 makers of cars, the process of standardization is advanced; likewise, if a given make of motor is adopted by many makers of cars, the process of standardization will be present to whatever extent the given make of motor is put into circulation.

The great underlying question comes with the consideration of the raw materials used by the respective accessory makers, it being the case that if there is no standard to go by, each accessory maker independent of the other will suit his own convenience or consult his personal ideas, under which conditions the materials will vary over the wide limits of the market, and to some extent price will be the governing factor, whereas when a standardized condition is recognized the question of the cost per unit of the material ordered will be reduced to a mere matter of bookkeeping, for if there is a standard set for the quality of the material there will be a standard price as well.



Chalmers "Thirty," 1910 | Locomobile "Thirty," 1910 | National 40 H.P., 1910 | Abbott-Detroit "Thirty," 1910 | American Traveler, 1910 | Maxwell Model G-4

Midsummer S.A.E. Meeting

COUNCIL OF S. A. E.

H. E. COFFIN.....President
HENRI G. CHATAIN.....First Vice-President
R. C. CARPENTER.....Second Vice-President
A. H. WHITING.....Treasurer
COKER F. CLARKSON.....Acting Secretary
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W. G. WALL.....Manager
H. F. DONALDSON.....Manager
THOS. J. FAY.....Past President
HENRY HESS.....Past President

FINANCE COMMITTEE

H. M. SWETLAND, Chairman.
A. L. RIKER, W. G. WALL, A. H. WHITING,
W. S. GORTON.

WITH its absorption of the Mechanical Branch of the Association of Licensed Automobile Manufacturers the Society of Automobile Engineers came into its proper sphere of usefulness and importance with relation to the development of the automobile.

This great step in a progressive way was not accomplished in a day or a year. It followed after the Society of Automobile Engineers had been in existence for over five years, and it resulted from conditions that had been changed by its efforts. These changes took place gradually, but with a cock-sure certainty that made a forecast of the actual happening something more than guesswork.

The Mechanical Branch of the A. L. A. M., composed of engineers employed by members of the association in the building of automobiles, did a great work, and had a distinct purpose in life, but the time eventually came when its purposes would best be served by a disinterested association such as the Society of Automobile Engineers, to whom the work was turned over.

To-day the society, as it stands, represents the soul of the automobile business in the United States. From it come the impulses that make for advancement along structural and mechanical lines. With a membership a little short of 300, it includes the most advanced thinkers and workers in its field of endeavor, which covers the greatest and most important item in modern commerce—the automobile.

As a single example of the work already performed by the society, attention may be directed to the earnest, painstaking labor which resulted in the introduction of alloy steels into the manufacture of American automobiles. If the only claim of the society upon fame was bound up in this single item its results have been sufficiently important to justify the society in living indefinitely.

In a score of different ways it has proved its value and its practical availability. Founded upon a creed of the highest ethical character; trammeled by no stringent commercial limitations, the society is free to delve into research; to experiment, theorize, discuss, and with the utmost latitude, to reach conclusions.

THURSDAY

9 A. M.

Business session, President's address and reading of reports, followed by a general discussion of announced subjects.

2 P. M.

Professional session.

7 P. M.

Society dinner, followed by a professional session and general discussion.

Subjects not scheduled will come up during the dinner, at which time it is expected that all the members will be present, and in a receptive mood.

History, Growth and

The engineering problems that arise in manufacturing; the basic development of the automobile and the fundamental principles of mechanical art, all come under the scrutiny of the society. The theses read at its meetings and the discussion that arises from them, go clear to foundation axioms of mathematics and the structures built upon these foundations extend far and away beyond the lines of present practice.

As an illustration: Several years ago, during the period when ordinary steel was being used freely in the manufacture of automobiles, in America, the society kept a watchful eye upon experimental work with alloyed steel in Europe. Detailed experiments were made and the value of the alloys was demonstrated by the work of the scientists. There was sharp protest from the manufacturers of steel in the United States, and much opposition was developed against the introduction of the improved metals in the making of American automobiles.

It was difficult to arrange for the first importation of fifty tons of this material, and when the shipments became so large that they could not be ignored by the foundrymen, the American steel trade bowed to the dictum that had been pronounced in favor of the alloyed steels and the effect upon manufacture of motor cars to-day is emphatically felt throughout the country.

The history of the Society of Automobile Engineers covers a little more than five years. Along in the Spring of 1905 a

PROGRAMME

THURSDAY—9 A. M.

The Society of Automobile Engineers—the lines along which the organization may be made of the greatest value to its members individually and to the motor car industry.
The Society Constitution and Its Limitations.
Suggested amendments to the Constitution, which may facilitate the practical work of the Society.
The Publication of a Digest of Technical Literature.
The Conduct of a Reference Library.

2 P. M.

The Specification and Heat Treatment of Automobile Materials. Address by Mr. Henry Souther.
The Test of a 20-Horsepower Franklin Air-Cooled Motor. Conclusion of paper by L. R. Evans and R. P. Lay. By Prof. R. C. Carpenter.
Variation of Current Practice in Anti-Friction Bearings. Paper by D. F. Graham.
The Pyrometer—Its Development and Use. Paper by W. H. Bristol.
Hardness of Metals. A. F. Shore and H. G. McComb.
Lessons to be Learned from the Motor Car Contest.
Drive-Shaft versus Rear-Wheel Brakes.
Three-Point versus Four-Point Suspension.

AFTER SOCIETY DINNER

Report of Committee on Tire Efficiency. By F. J. Newman, Chairman.
Report of Committee on Gear Steels. Dr. G. W. Sargent, Chairman.
The Basis for Motor Car Taxation. Charles Thaddeus Terry.
The Establishment of a Court of Patent Appeals. By E. J. Stoddard.
How to Make Gears Quiet by Grinding. Frederick A. Ward.
The Responsibility of the Motor Car Engineer to his Company and to the Public.

FRIDAY—Afternoon (on Shipboard)

Seamless Steel Tubes and the Necessity for Standardization in Their Specifications. By H. S. White.
Slide, Rotary and Piston Valves versus Poppet Valves for Gas Engines. By Eugene P. Batzell.
Ill-Smelling and Smoky Exhausts. Paper by F. D. Howe.
Wheel Alignments—Camber and Foregather.
Hot Rolled Gears (Teeth Rolled In) for Transmission and Differential Purposes.
Best Tooth Form for Quiet Gears.
Valve Seat Angles.

Midsummer S.A.E. Meeting

Work of the S. A. E.

handful of progressive scientific men recognized the utility of an organization of automobile engineers, in which nothing but the advancement of practical science should have any weight or influence. These men, among whom were H. M. Swetland, president of the Class Journal Publishing Company; A. L. Riker, vice-president of the Locomobile Company of America; Henry Ford, president of the Ford Motor Company; E. T. Birdsall, A. H. Whiting, L. T. Gibbs, H. P. Maxim, H. F. Donaldson and Henri G. Chatain, representative engineers, attended a preliminary meeting which eventually resulted in the formation of the Society of Automobile Engineers.

PROGRAMME

SATURDAY—9 A. M.

Motor Trucks for Railroad Service. Paper by T. V. Buckwalter.

Test Data Upon Sheet Metal Frame Sections. By L. R. Smith.

Proper Power and Speed for Gasoline Motors for Truck Purposes, and Proper Road Speeds for Vehicles of Different Capacities.

Location of Motor for Commercial Vehicle Work—in Front Under Bonnet or Under Seat.

Long-Stroke versus Short-Stroke Motor—Advantages and Disadvantages of Each.

Driver's Seat on Left versus Driver's Seat on Right for Commercial Car Purposes.

The Edison Battery in Practical Vehicle Service.

Electric Vehicle Mileage.

Foolproofing the Commercial Car Mechanism and Its Control.

Standardization Possibilities Within the Commercial Car Field.

A Proper Nomenclature in the Distinction of Freight and Passenger Vehicles.

Tire Mileage and Costs.

1 P. M.

Nomenclature of Motor Car Parts. Paper by F. E. Watts.

Driver's Seat on Left versus Driver's Seat on Right for Pleasure Car Purposes.

Leaf Springs, Methods of Mounting and the Treatment of Springs by the Manufacturer and in the Hands of the Motor Car Owner.

Magneto Efficiency.

Current Practices in Lubrication and the Practical Results Obtained.

Standardization Problems. Those matters which deserve the united attention of the motor car engineers in an effort to simplify the purchasing department and deliveries problem. Also matters affecting the car-user.

Cork Insert Pulleys as Applied to Motor Vehicle Manufacturing Machinery. Lawrence Whitcomb.

The Carrying of Tools and Spare Tires on the Car. By H. H. Brown.

LOCAL ENTERTAINMENT COMMITTEE

Howard E. Coffin (ex-off.)
H. W. Alden, Chairman
George W. Dunham
Russell Huff
H. M. Leland
F. E. Watts
E. T. Birdsall
A. P. Brush
F. H. Floyd
G. M. Holley
G. E. Merryweather

The object of the society, as set out in its constitution, was to promote the arts and sciences connected with engineering and mechanical construction of automobile vehicles.

The method by which this object was to be attained was to hold meetings for the reading and discussion of professional papers, for social intercourse, the publication and distribution of its papers and discussions and the maintenance of an engineering library.

The industry was emerging from its swaddling clothes when the society was brought into existence, and the keynote that was sounded at its early meetings found a protesting echo from the infant industry. Up to that time it had been the practice to take several European models and strike a kind of mean average in the building of motors, the construction of running parts and the general architecture. The result was not much more than a mean average, and pretty mean at that, although even in that early day of the industry some creditable advances were made along structural lines.

The early activity of the society was marked by no splurge and noise, but a vast amount of conscientious work was done by its members. Its growth was steady from the first, and it soon gave evidences of its permanency. Mr. Riker was chosen first president, and under his administration the foundation was marked out for the great structure that now stands upon it. During the first year a considerable portion of the effort of the society was devoted to perfecting its organization and preparing for its work. At the end of the first year of formal operation Mr. Riker was re-elected as presiding officer, with Henry Ford, vice-president; John Wilkinson, second vice-president, and E. T. Birdsall, secretary-treasurer. A. H. Whiting, L. T. Gibbs, H. M. Swetland, H. P. Maxim, W. H. Alden and H. Vanderbeek were selected as its Board of Managers.

The society had now grown to nearly 100 members, and at its second annual meeting, which was held in New York, January 17, 1907, papers were read by Thos. J. Fay, E. E., on "Some Features of Construction"; by Thomas L. White, on "Alcohol as a Fuel for the Automobile Motor"; by Henry Hess, on "Automobile Change Gears and Their Journals," and by Henri G. Chatain, on "Some Facts Pertaining to Electrical Ignition."

Mr. Fay's address outlined the purpose of the society with much clarity. In introducing his subject, he said: "In attempting to elaborate upon features of construction of motor cars, the dominant idea will be to discriminate as between things tried out and found wanting, things tried out and found satisfactory, and things in the air, so to speak.

"It is believed a society of engineers, to serve a useful end, should act as a 'clearing-house' for engineering practices, rather with the expectation of ultimately fixing upon standards to go by. It is not the purpose here to advocate any scheme likely to limit the zone of activity of inventors, or place one in the position of having to conform to narrow conventions.

FRIDAY

9 A. M.

Visits to various manufacturing plants (members to elect three plants which they individually desire to visit; Parties will be grouped accordingly).

1 P. M.

Boat trip as guests of the Timken-Detroit Axle Company, during which there will be a professional session on shipboard, followed by a general discussion of several subjects.

EVENING

Social session, with dinner at Light House Inn for those attending the convention and the ladies accompanying them.

SATURDAY

9 A. M.

Professional session, at which Commercial Vehicles will be the main topic, followed by the reading and discussion of several papers.

1 P. M.

Professional session and general discussion of subjects.

ADDITIONAL SUBJECTS FOR DISCUSSION

Cylinders; crankshaft bearings; cylinder heads; valves; piston-rings; cooling; gasoline; noises; brakes; gear-box forms; number of cylinders; fixed ignition; multiple sparking; gear ratios; rear axles; stock cars; worm drives; relation of power to demands.

"On the other hand, it is feasible to aid invention and broaden the range of vision by limiting the amount of details to be mastered, as well as decreasing the repetition of errors, costing, as they do, lives and money."

Mr. Fay then pointed out the supreme advantages of critical consideration and discussion in their relation to condemnation of bad practice and unsound theory.

He presented an advanced view of the use of alloyed steel, recounting his conclusions from a series of exhaustive experiments with nickel-chrome steel. He called attention to the dangers of excessive phosphorus and sulphur in certain varieties of metal used in the composition of this sort of alloyed steel, and gave the figures of his tests in great detail.

After showing the advantages of chrome-nickel steel, Mr. Fay concluded that the price of steel is no sign of its quality, and that good carbon steel at 2 cents a pound was better than bad chrome-nickel steel at 20 cents a pound. He also said that nickel steel, while holding some good qualities, was too uncertain in the stage of development that obtained at that time for use in cars of pretension.

He cited a particularly interesting incident where the carbon steel shaft of an expensive foreign car under his observation twisted in service and said that the engineer, figuring on a much higher elastic limit than was justified, had used carbon steel instead of chrome-nickel steel of the type used by a competitive maker.

He sounded a note of warning against the use of too light aluminum in crank cases and transmission cases, and pointed out the advantages of bronze for those purposes.

"Alcohol as a Fuel for the Automobile Motor," a subject close to the automobile craft, and one that will probably occupy much attention in the years to come, was treated by Thomas L. White.

In introducing his subject, Mr. White said that the economic conditions which must eventually obtain in motordom as to the use of alcohol for fuel, must be considered independently of technical considerations. He pointed out that gasoline is a by-product of a geographically limited and monopolistically controlled industry, and that the whole available and prospective supply is more than mortgaged by the wide demand.

He showed that alcohol could be manufactured almost anywhere for 5 cents a gallon, and that in the view of supply, the conditions were more promising than those that obtained in the gasoline line. He called attention to the fact that if the technical difficulties that stand in the way of using alcohol in place of gasoline could be removed, the demand created for alcohol will be satisfactorily met as to quantity, quality and price.

Mr. White showed by a series of experiments that alcohol requires 6 per cent. of its caloric value to complete its evaporation; that with ordinary compression the inflammation rate of the motor alcohol is sluggish as compared with gasoline; that a 10 per cent. addition of water lends itself to a compression of 150 pounds and upward; that in process of inflammation it does not radiate heat so rapidly as gasoline; that it is most efficient when the walls of the cylinder are maintained at 200 degrees Fahrenheit, and that the penalty for incomplete combustion is corrosion and destruction of valve seats and exposed parts, as well as loss of power.

He pointed out that the aim of the engineer should be toward perfect carburetion with the aid of exhaust heat; acceleration of the inflammation in the cylinder and the maintenance of the heat of the cylinder walls at 200 degrees. He said that in slow-going motors the use of fuel alcohol had proved a success, and suggested that future work in this line should be to carburate air with alcohol, instantly, and to promote approximately instant inflammation at maximum compression. He proposed that air containing partly atomized and partly vaporized alcohol be passed through a layer of calcium carbide before the mixture enters the cylinder. The 10 per cent. of water in the alcohol mixture would generate acetylene gas and the heat thus generated would evaporate the alcohol. He expressed the hope that the future would demonstrate in practice the utility of the idea.

The paper of Henry Hess, on "Automobile Change Gears and Their Journals" was another important address. Mr. Hess went clear to the roots of the problems involving ball bearings. He outlined the best practice of the day, and showed the trend that development must take both here and abroad. How thoroughly justified were the conclusions of Mr. Hess may be realized when it is considered that the ideas he advanced then seem almost like the regular specifications of to-day.

Mr. Chatain's address on "Some Facts Pertaining to Electrical Ignition" detailed a series of tests with the low-tension magneto and high-tension coils, which was an authoritative statement of the most advanced ideas of that day.

At the next quarterly meeting of the society, which was held at Buffalo, a series of papers was read by J. M. Ellsworth and Thos. J. Fay, on "Some Micro-Structural Considerations," on "Pointers on the Equipment of a Hardening Room," by J. G. Schaeffers, on "Construction of Motor Vehicle Springs," by J. G. Rumney, on "Influence of Acid and Rust on Ball-Bearings," by Henry Hess, and on "The Carbureter and Its Functions," by Charles E. Duryea.

The program was composed of strictly technical presentations, and marked a distinct step in the life and progress of the society.

The next meeting was the third annual convention of the society, and was held in New York. The program included addresses by Henry Hess, on "Automobile Hub Bearings"; H. W. Alden, "Some Notes on Taper Roller-Bearings"; J. M. Ellsworth and Thos. J. Fay, on "Usually Unobserved Refinements of Construction," and by Thos. J. Fay, on "Nature Hard Gears."

The following officers were elected: President, Thos. J. Fay; first vice-president, Henry Ford; second vice-president, E. T. Birdsall; and treasurer, Henry Hess.

The transactions of the society began to broaden in scope and influence, and during the year that followed a vast number of important subjects were considered, presented and discussed. The quarterly meetings were held in various cities, the first being called to order in Boston, second at Detroit and the third at Cleveland. The speakers and their subjects at these meetings were as follows: J. O. Heinze, on "Perfecting Automobile Ignition"; P. M. Heldt, on "The Design and Construction of Crankshafts"; Joseph A. Anglada, on "A Multiple Unit System as a Solution of the Heavy Goods Transportation Problem"; Richard W. Funk, on "Forgings for Automobile Work"; E. S. Foljambe, on "Autogenous Welding and Its Application to Automobile Construction"; Otto Heins, on "Some Recent Developments in Magneto Ignition"; Bruce Ford, on "The Storage Battery in Automobile Work"; Frank Beemer, on "The Unit System of Power Transmission in Automobiles"; A. L. Dixon, on "Increased Efficiency of Single Motor Drive"; H. Vanderbeek, on "The Limitations of the Universal Joint"; Thos. J. Fay, on "What Carbon Does to Automobile Steel," and Leon Lacon, on "What Is the Best Timing."

The breadth of thought included in the foregoing subjects is a measure of the activity of the Society of Automobile Engineers, and shows better than any mere comment the value of such an organization as a moving force in the development of the American automobile.

At the next annual meeting of the society Henry Hess was chosen president, with Russell Huff, first vice-president; B. D. Gray, second vice-president; A. H. Whiting, treasurer, and Alex. Churchward, secretary.

The work started and accomplished during the earlier period of its life was continued and expanded under the administration of Mr. Hess. The deliberations of the society had attracted attention, not only of motordom in America and Europe, but of scientists everywhere, and proposals of a flattering nature were made to the society to join forces with other scientific organiza-

Midsummer S.A.E. Meeting

tions that were only interested in the automobile from an academic viewpoint. These were declined with thanks and appreciation of their complimentary nature, and the S. A. E., now come to commanding size and influence, stepped forth full grown into the glare of focal interest.

The program for the year included the following speakers and subjects: Lawrence Whitcomb and Thos. J. Fay, on "The Trend of Brake Design"; A. Atwater-Kent, on "What Constitutes Ignition Reliability"; F. D. Howe, "The Economics of Weight Reduction"; William S. Noyes, "An Improved Type of Compression Coupling"; S. W. Rushmore and Herbert L. Towle, "An Indicator with Continuously Rotating Drum"; S. P. Wetherell, Jr., "Standardizing Motor Bearings"; Henry Cave, "Some Practical Considerations in Autogenous Welding." The Summer convention was held at Chicago, with the following program: R. C. Carpenter, on "Test of a Pierce Six-Cylinder Motor"; Edward Sokal, on "Possible Increases of the Weight Efficiency of Storage Batteries"; H. M. Beck, on "Some Points in the Operation and Care of Vehicle Batteries"; Frank H. Floyd, on "Notes on Lubricating Oils"; Alexander Churchward, on "Energy Consumption of Commercial Vehicles"; H. S. Baldwin, on "Electric Cradle Dynamometer—Method for Test of Gasoline Engines."

Thus may be traced the expansion of the society's field of work from first principles to the ultimate refinements and back to first principles again. Each meeting marked a step in advance; each successive consideration of a certain subject carried along the line of thought first laid down and when the limitations had been reached the conclusions were used either to break down what had been deemed a fundamental principle or to strengthen its position as a cornerstone of the great engineering fabric.

At the last annual meeting of the society H. E. Coffin, president of the Hudson Motor Car Company, was elected president; Henri C. Chatain, one of the charter members of the society, was honored with the first vice-presidency, and R. C. Carpenter succeeded to the second vice-presidency. A. H. Whiting was re-elected treasurer and Coker F. Clarkson was named acting secretary.

There was another field of usefulness in view for Mr. Clarkson, who at the time was assistant general manager of the Association of Licensed Automobile Manufacturers, and coincidentally with the absorption of the Mechanical Branch of that association by the society, Mr. Clarkson was made general manager of the society. Permanent offices were secured at 1451 Broadway, New York, and a program of still greater activity is being outlined.

Bound by no commercial or financial limitations, and moved only by the considerations that aim to improve and develop automobile engineering, the future stretches away into pleasant vistas of teeming activity.

Members, Associates, and Junior Members

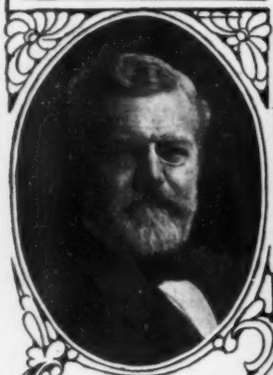
Members.—William F. Abel, W. J. Aitken, H. W. Alden, Edmond E. Allyne, H. B. Anderson, Joseph A. Anglada, V. G. Apple, Bertram Bailey, Walter C. Baker, Henry S. Baldwin, F. W. Barker, E. J. Bartlett, John W. Bate, A. K. Baylor, Edward W. Beach, Frank Beemer, Edward B. Belcher, Albert C. Bergmann, F. C. Billings, E. T. Birdsall, George G. Bowersox, F. R. Boynton, S. S. Breese, Patrick H. Brennan, John W. Breyfogle, Alex. T. Brown, H. H. Brown, D. T. Brownlee, A. P. Brush, Tracy V. Buckwalter, W. H. Cameron, Rolla C. Carpenter, Henry Cave, Frederick Charavay, J. C. Chase, Henri G. Chatain, Alex. Churchward, Raymond Cilley, L. K. Clark, Coker F. Clarkson, C. E. Clemens, Albert L. Clough, John Coapman, Howard E. Coffin, Herbert C. Colburn, Ernest Coler, L. W. Collord, Edwin K. Conover, J. S. Conwell, Frank W. Cooke, Claude E. Cox, Henry M. Crane, Harry R. Croninger, John A. Crowley, Charles Cuno, Hermann F. Cuntz, L. C. Dalley, H. Dalton, E. R. Davies, C. E. Davis, Frank S. Davis, [illegible] M. Dieterich, Marcel E. De Jarny, Archibald L. Dixon, H. P. Dodge, H. F. Donaldson, A. J. Doty, George W. Dunham, Arthur N. Duckworth, Charles E. Duryea, H. J. Edwards, A. H. Ehle, Edward Ehler, Burton G. Ellis, John M. Ellsworth, Justus B. Entz, S. S. Eveland, William Fay, Thos. J. Fay, Roland S. Fend, David Fergusson, H. George Field, J. F. Firestone, R. A. Fliess, E. S. Foljambe, Bruce Ford, Henry Ford, William V. Forrest, James H. Foster, G. E. Franquist, Lowell C. Freeman, Richard W. Funk, R. G. Garretson, W. J. Garrod, Paul Gaeth, G. A. Gemmer, E. T. Georges, Christian Girl, Asher Golden, D. F. Graham, B. A. Gramm, B. D. Gray, William Gray, Charles R. Greuter, Emil Gruenfeldt, W. C. Guilder, H. J. Hass, C. L. Halladay, Thomas D. Hanauer, G. Hartman, Adam L. Haskell, William Hasselkus, C. L. Hastings, Charles B. Hayward, A. E. Hegardt, Otto Heins, Edwin Heinsohn, John O. Heinze, P. M. Heldt, Charles F. Herreshoff, William Herreshoff, James H. Herron, John H. Hertner, Henry Hess, Edward R. Hewitt, G. M. Holley, Arthur Holmes, H. K. Holsman, William S. Hovey, F. D. Howe, Lindley D. Hubbell, W. R. Hudson, Daniel Huff, Russell Huff, S. V. Hunnings, P. L. Hussey, M. R. Hutchinson, F. R. Hutton, R. B. Jackson, Edward B. Jacobson, Charles T. Jeffreys, Stephen Jencick, H. M. Jerome, Daniel E. Johnson, Frank Johnson, Ray Prescott Johnson, L. C. Kenen, W. P. Kennedy, A. A. Kent, W. P. King, Charles B. Kirkham, James A. Kline, Walter F. Kneip, M. C. Krarup, Louis Krynitz, David Landau, J. M. Lansden, Jr., Charles M. Lansing, F. A. Law, C. L. Lawrence, Edward S. Lea, H. M. Leland, W. H. Little, G. J. Loomis, Marcus T. Lothrop, Victor Lougheed, William V. Lowe, Charles E. Lucke, Ernest Lunn, Henry G. McComb, Stewart McDonald, H. B. MacFarland, R. S. McLaughlin, George C. McMullen, A. L. McMurtry, John M. Mack, A. M. Manross, A. F. Masury, Frank F. Matheson, H. P. Maxim, V. St. J. Mayo, G. E. Merryweather, E. R. Mertens, Albert R. Miller, H. P. Moorrees, Watt L. Moreland, B. Morgan, F. E. Moskovics, C. S. Mott, Arthur J. Moulton, Theo. M. Muller, F. P. Nehrbas, B. B. Neuteboom, Frederick J. Newman, Richard T. Newton, Lars G. Nilson, Warren Noble, R. E. Northway, Louis M. Pawlett, J. A. Perkins, J. G. Perrin, Rene M. Petard, Charles Pleuthner, N. B. Pope, Jesse T. Pratt, P. A. Proal, Thomas Prosser, W. H. Radford, A. E. Ranney, Henry Rawle, C. E. Reddig, B. P. Remy, A. L. Riker, Edward V. Rippingille, Adolph Rosner, David Dwight Rowlands, Richard F. Russell, E. A. Rutenber, George S. Saltzman, O. Sandberg, Eric S. Sandgren, G. W. Sargent, Joseph Schaeffers, G. B. Schon, Albert C. Schulz, R. C. Shaal, A. J. Slade, Ernest Locke Smith, H. Smith, Paul L. Snutsel, Edward Sokal, Henry Souther, Lorillard Spencer, Jr., Clarence W. Spicer, W. H. Staring, F. B. Stearns, P. S. Steenstrup, Oscar Stegeman, J. G. Sterling, G. E. Stone, H. M. Swetland, Cecil Hamelin Taylor, P. S. Tice, Herbert L. Towle, Morris S. Towson, Joseph Tracy, H. L. F. Trebert, Amasa Trowbridge, William Hall Tuthill, John G. Utz, H. Vanderbeek, W. H. Vandervoort, Scott Van Etten, Guy W. Vaughan, B. G. Von Rottweiler, W. G. Wall, Charles A. Ward, Frank E. Watts, G. A. Wells, Jr., H. H. Wesener, Thomas L. White, Allan H. Whiting, Clarence E. Whitney, E. R. Whitney, Frank E. Whitney, E. C. Wilcox, John Wilkinson, Joseph A. Williams, Henry C. Wilson, Earl W. Winans, Newton A. Wolcott, George F. Woolston, Millard S. Young, Arthur Ziltener, Thomas Zimmerman,

Associate Members.—Frank M. Ashley, E. W. M. Bailey, Day Baker, Fredson E. Bowers, George K. Bradfield, J. S. Bretz, H. A. Buzby, C. D. Cramp, Earl C. Eldredge, Frank Harris Floyd, Peter Fogarty, W. S. Gorton, George O. Gridley, F. J. Groth, L. A. Hill, Joseph P. Lavigne, G. W. Mather, John A. Mathews, D. G. McDiarmid, George C. Miller, A. R. Mosler, William S. Noyes, J. B. Ryall, Dempster M. Smith, E. W. Stevens, B. C. Swinehart, W. R. Timken, L. M. Wainwright, S. P. Wetherill, Jr., L. W. Whitcomb, H. S. White.

Junior Members.—Irving W. Adams, H. L. Hess, Jr., James McK. L. Howe, Myron D. McCauley.

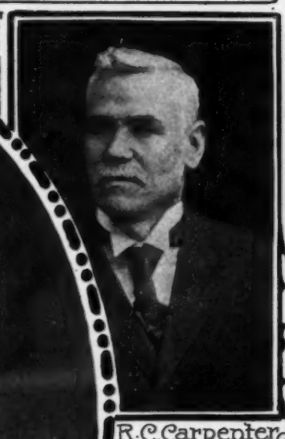
Midsummer S A E Meeting

COUNCIL


F. R. Hutton

H. G. Chatain
1st V. Pres.

H. E. Coffin
Pres.


R. C. Carpenter
2nd V. Pres.

C. F. Clarkson
Act. Sec.

D. Ferguson
Mgr.

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Mgr.

Thomas J. Fay
Past Pres.

Henry Hess
Past Pres.

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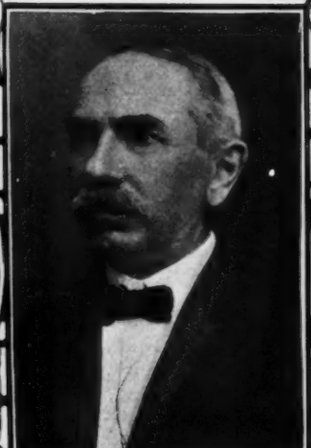
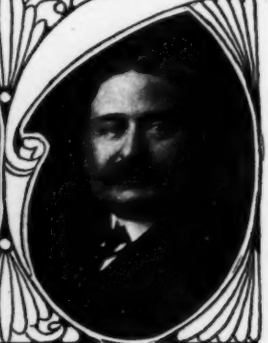
B. D. Gray

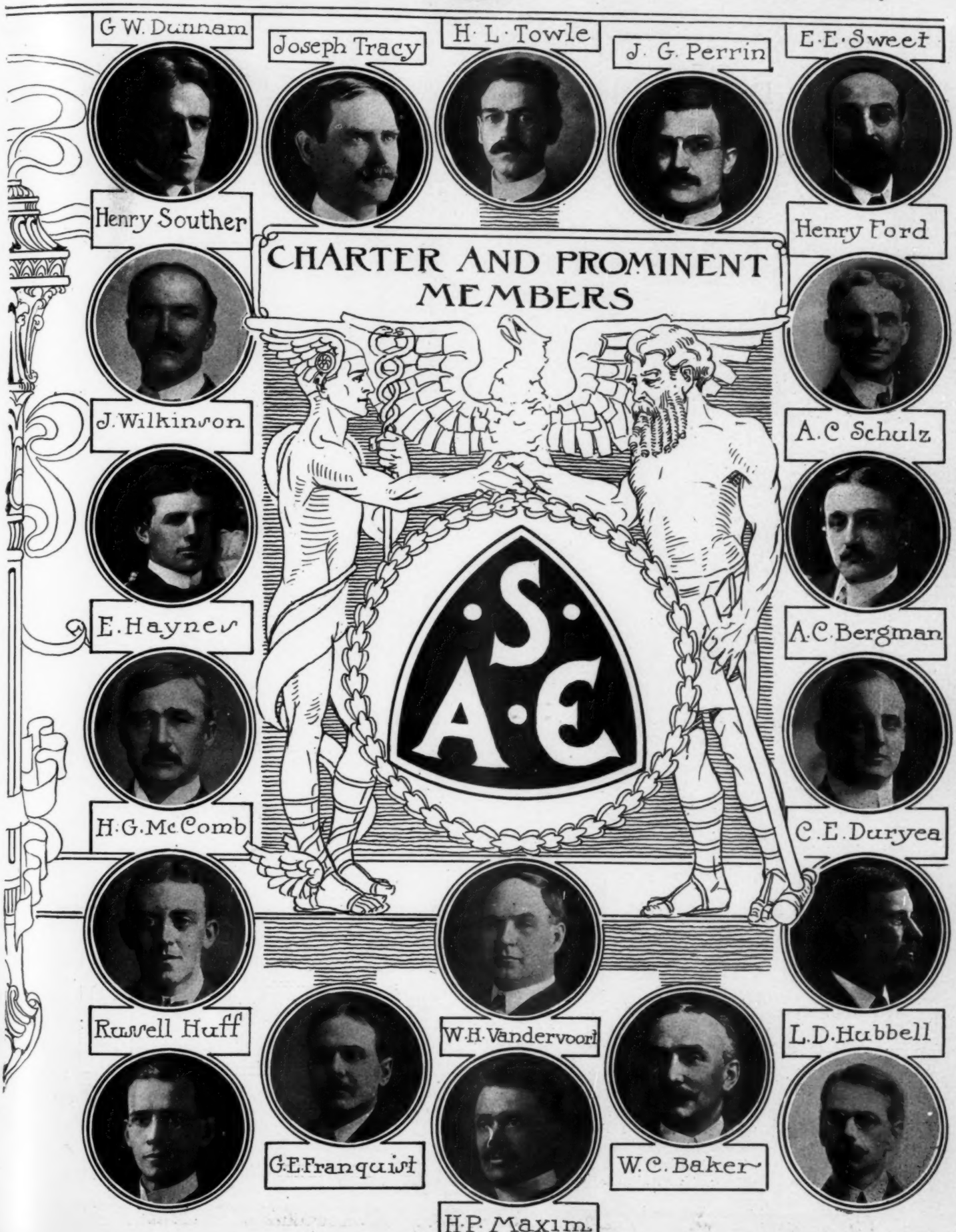
A. L. Riker
First Pres.


H. M. Swetland
Chairman

H. W. Alden


E. T. Birdsall

Midsummer S.A.E. Meeting



Study Depicting the Trend in Torpedo Body Designing

INDICATIONS point in the direction of the torpedo type of body with four doors, thus affording access to the driver's seat on either side as well as access to the tonneau. To accomplish this it is necessary to place the emergency brake and sliding-gear lever amidship in the car, and the steering wheel must be placed on the left side. In addition to an arrangement such as this, the illustrations are of a new design which is intended to serve as a "study" in which will be found a definite interpretation of the trend in its various aspects of the automobile body designing situation.

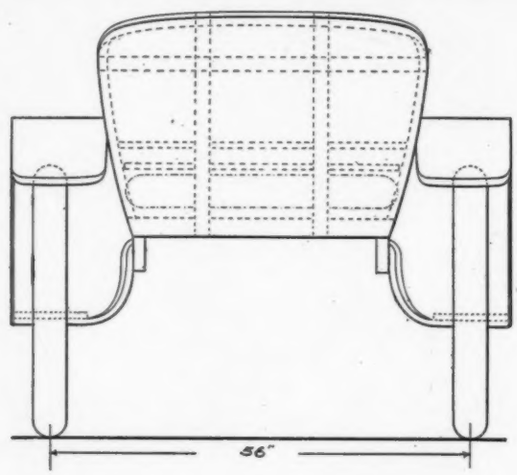
Among the important refinements indicated is the one which protects the radiator from splashes of mud without in any way interfering with the working qualities of the radiator, nor can it be said that the appearance is otherwise than enhanced. As a further suggestion which will carry weight among veteran tourists, is the idea of making a tire "cellar" beneath the floor of the tonneau, with means of access, which is quick and convenient, possessing the added virtue of a secure lock against the wiles of those who want tires but are reluctant to pay for them.

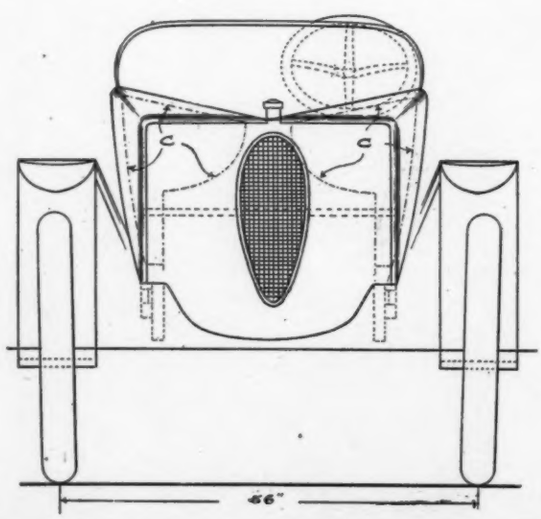
Arguing in favor of the elimination of appended accessories to the glistening surface of a highly finished body makes it necessary to find a place for each of them. If it is desirable to build a tire cellar for the pneumatics, primarily to get them out of the way, at the same time affording protection against thievery, and the further fact that the direct rays of the sun are intense destroyers of tire life, it is equally desirable to place the gas tank in its own compartment, thus removing an unsightly appendage from the running board, and placing the gas tank where the direct rays of the sun will not shine upon it and add to the risk of an explosion, which is always a possibility if heat is applied to the tank.

A second look at this new design will carry the conviction that the occupants of the front seat are afforded the same protection against the wiles of inclement weather as that available to the occupants of the seats in the tonneau. The front entrances were placed so far back that it was necessary to design the seats so that they could be tilted sufficiently to admit of entering, but this plan permits of overhanging the dash sufficiently to house in the occupants of the seats, and by a special shape of the overhang, even the hands of the driver are protected from drafts of wind, thus permitting him to grasp the steering wheel firmly and to enjoy driving even in zero weather. The shape of the overhang is such that the wind is given an upward trend, and it sweeps away over the heads of the occupants of the front seat, thus giving to them all the protection of a glass windshield with none of the disadvantages, as dimming the vision, when mist forms on the glass.

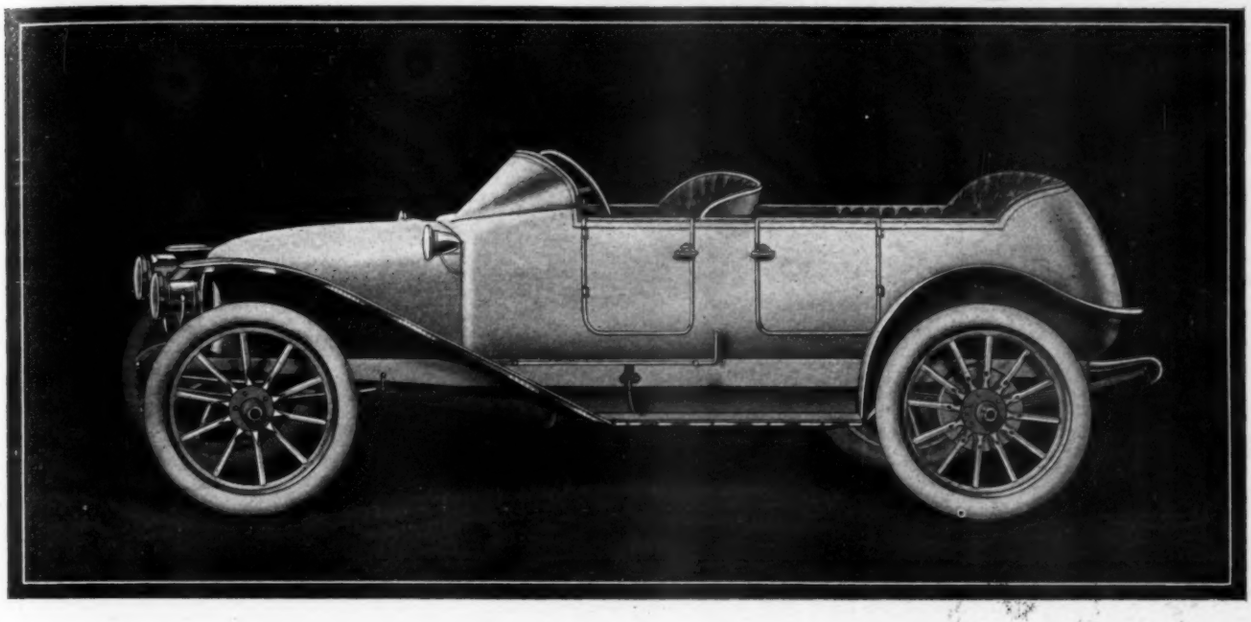
The fuel problem is solved on a simple basis. It is assumed that an autoist who travels from his place of abode to the point of his destination will desire to come back again. It is also assumed that the best automobile is the one which has the least number of intricate parts, so that gravity feed is resorted to, thus eliminating the pressure regulator. Two tanks are shown.

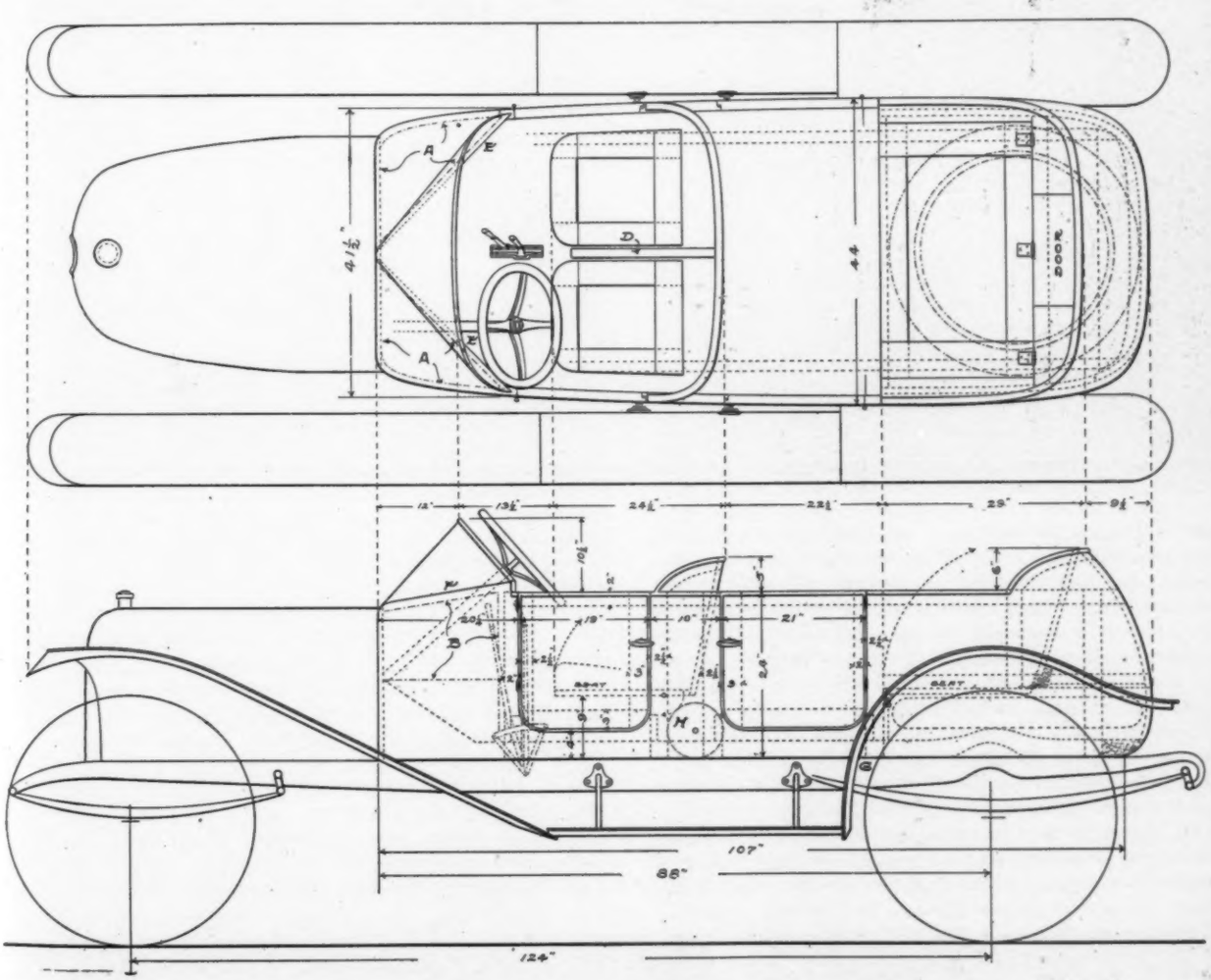
Progress was made when the torpedo scheme took root in body designing. The idea of affording protection to the occupants of the front seats is one that is appreciated by every autoist of experience, and the shaping of the overhang of the dash so that the "dodger" improvement is incorporated, lends favor to the plan. Then, the scheme which eliminates dust accumulations from the person of the passengers in the rear seats gains a measure of appreciation, but it remains for designers of bodies to devise some plan for storing the tires, acetylene tank, and the other accessories, so that they will not continue to detract from the appearance of the car. Pilferers, who go about purloining accessories from automobiles, are ever favored by the ease with which the accessories can be gotten at, and certainly it is worth while to give them more work if they must be dealt with at all. The body, as here presented, is designed to afford protection in the several ways. The shaping of the front of the hood is protective with an opening just large enough to allow of the passage of the requisite amount of cooling air, and the baffling influence necessary to prevent splashes of mud from entering the radiator and passing back to the machinery.



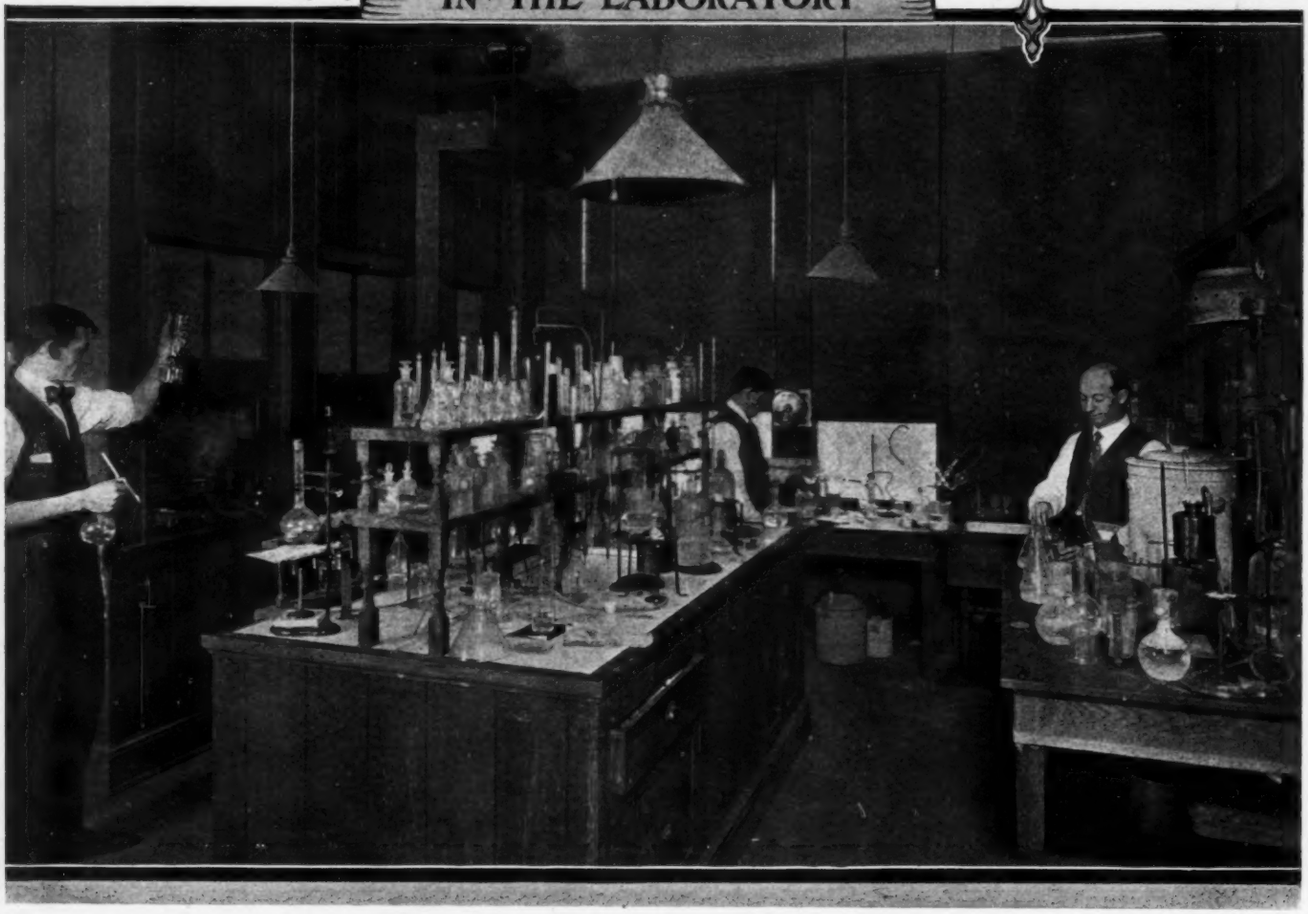


Midsummer S.A.E. Meeting





AUTOMOBILE STABILITY STARTS IN THE LABORATORY



NEVER before, in the history of the doings of men, was the time ripe to balance the efforts of the workers in the vineyard of human endeavor. The men whose feet have contact with the "cash box," holding a certain temporary potential standing, were never slow to take advantage of the fact. "Business reasons" were ever at the bottom of loose statements of position, so that engineers, bound down by high aims, and with a proper regard for truth, were kept at the foundation of the structure, there to take the weight of all, with never a chance of correcting the ills which creep in, excepting by primary means reduced to a low state of efficiency as interpreted by business men who are wont to claim that an engineer is not practical.

With the coming of the automobile, and the broadening of the scope of the work that engineers have to do, business men have been compelled to lean more heavily upon the technically trained, and the closer contact has brought about a better understanding and a more healthy combination. The elimination of ruinous competition has had a wider influence upon the newer movement than most economists are ready to admit. As business is now done, it is not necessary to engage a "confidence man" to represent a company, and merit is the most prized stock in trade. Companies are fast learning that merit is not a companion to "sharp practice"; they also find that engineers are not to be depended upon to do a task excepting in the right way.

In the old days men were prized as they showed capabilities in the direction of making purchasers believe that black was white if the exigency demanded. Under the new conditions it only remains to deal with purchasers who are not color blind. Merchandise is produced and sold for what it is, and customers are relied upon to order what they want, so that misrepresenta-

tion is no longer necessary. This newer condition, however, has introduced a demand for more skill on the part of the men who do the work just in proportion as the demand for "slick talking" is falling off.

When it comes to doing things as they should be accomplished, there is no chance of being able to improve upon the methods that engineers learn, not only at the universities, but in the shops also. When a man starts out to build a machine of any sort he must be sure of his ground and design all the parts so that they will fit together. This necessity is so pressing that every man engaged in this character of undertaking fully appreciates the advantage of being honest with himself, knowing that if he neglects to take every factor into account the machine will fail to go together and he will have to pay the price of his disregard of first principles.

This drilling along lines that bespeak accuracy has a wide influence on the men and they are continually baited along the paths of honesty of habit and good intention. That this character of man is venturesome enough to suit the type of financier who wants to succeed on a basis of merit is too plain to be denied, and that the engineer will be of any use to the dishonest business man is impossible to believe.

The idea, then, that engineers have to be kept out of the business office because they are not "cute" is being given up. They are wanted there for the very reason that they know better than to deceive themselves, and a man who has this quality as a fundamental basis is the character of man who will not stoop to the point of deceiving his employer or the patrons of that employer.

The claim that the engineer is not progressive enough for business is refuted by the large amount of profitable business that is being done in the many walks of life, nearly all of which is based upon engineering effort. If a company must engage an engineer to design its product, and if the company admits that the engineer succeeds in doing so, he must be held responsible for the result of his handiwork, but he must be given credit for the good that comes therefrom. All the epoch-making advances along constructive lines, of which our form of civilization has any knowledge, are based upon engineering. The workmen who construct machines, whatever they may be, as locomotives, etc., follow the specific instructions of engineers, but this point is frequently overlooked, owing to the fact that the instructions are given in the form of drawings, specifications, rules and regulations.

All the careful work involved in bringing out an equipment is done under the direction of a competent engineer if the equipment is to perform in a proper and satisfactory manner. Just at this point the business office, not being able to discriminate between careful and systematic work as compared with spectacular executional manoeuvres, allows the initial painstaking effort to sink out of mind, but being unable to get away from the loud talk of the man who merely directs the execution of the work in the manner as laid down by the engineer, the conclusion is soon reached that all the push and energy and business acumen emanates from the character of the man who is keen enough to see that he must use the engineer's basis, but who makes enough fuss in the process of doing the work to swing the limelight so that it casts its beam upon his favored brow.

The coming of the automobile, while it is not to be held wholly responsible for the many reforms that are being made, has had much to do with the process of crystallization, and business men of the class who make a success of their endeavors are reaching the conclusion that there is nothing to be gained by traversing the road which is said to be the short cut to victory. When a business is traveling in the wrong direction, the shorter the road the quicker it goes to ruin. When a business is in the hands of the character of man who cares nothing about merit, the more energy he puts into the enterprise, and the more vim he offers as a fair exchange for his stipend, the greater will be the splash the wreck will make when it lands in the sea of oblivion.

The elimination of competition, then, is a step in the right direction. When a man faces ruin, let it be from competition or from any other cause, he is compelled to either throw up his hands or surround himself with the character of talent that is willing to rise to the occasion by stooping low enough to hold an advantage over his competitors who also pride themselves on their ability to stoop. It was called "business expediency;" it was not very different from a rather sad piece of business known as "political expediency," and in these days of straight business the right name is well understood—it is called "dishonesty."

The modern trend leads to the recognition of the man who depends upon his skill to produce results. The greatest step toward this fitting situation was made when it was decided that competition is dishonest because it demands dishonest methods to make it possible to survive, but in substituting a merit basis, which was bound to follow when the selling price was based on the cost plus a profit, it became necessary to employ men who are capable of performing an excellent service, in other words, engineers, it being the case that the word "engineer," viewing it broadly, is descriptive of a man of skill; nor does it make any difference whether he devotes himself to the building of a pyramid, battleship, bridge, an act of congress, or an automobile. The man of skill is in contrast with the character of man who was relied upon under the old conditions in just proportion to the lack of skill of the latter, he relying upon his high disregard of fair dealings, having in view the one idea, "get there."

During the early days of automobile building there were a large number of failures, owing to the lack of appreciation of the facts as herein roughly submitted. The engineering staff was overshadowed by the sales department and the business office, the questions of competition took precedence over the matters of quality, and the heads of these companies, lacking in keenness of vision, failed to appreciate the new spirit and fell by the wayside enmeshed in the warp of cleverness, disregarding the woof of substantiality.

Under the old conditions, the engineers beggared along, made the best showing they could in the face of little encouragement, were honest with themselves in that they performed their part of the service in the light of their high ideals, saved cost wherever it was possible to do so without reducing quality, and kept before them, in so far as they could, the main point of view. Failure came when the purchasing departments disregarded the specifications for materials, and bought cheaper stuff. If anything but disaster can follow after such an act it must be by accident. If an engineer decides that the extreme fiber strain, for instance, of a crankshaft will leave a factor of safety of four if chrome nickel steel is used, but if the purchasing agent substitutes an ill-contrived forging out of a Bessemer bar, the latter can only be charged with having listened to the wiles of the vender's "slick Sam" who had a surfeit of Bessemer forgings to get rid of, and knew enough to go to a company whose management lacked in sense, thus permitting an ignorant purchasing agent to abort the efficient labor of an intelligent engineer by a process no more intricate than the deliberate purchase of the materials which are not wanted, for no better reason than that the vendor wants to get rid of them and is willing to name a low price.

These evils have been largely corrected. To-day the purchasing agent is not infrequently a skilled metallurgist; he studies the engineer's specifications, has the drawings before him when he takes up the matter for consideration, and while he acts on his own initiative, he nevertheless appreciates the reasons why the engineering office puts out specifications and works over designs until they are perfected. The modern purchasing agent, having an engineering training, tells the vendor what he wants, using fitting language in his description, and ascertains the price of the product which will suit his purpose, with never a thought of stocking up on "white elephants." This new way of conducting the automobile business is the cheapest in the long run; it eliminates wasters, shrinks the junk pile to insignificance, hastens the delivery of the finished product, commands a higher price, and makes every customer a willing, animated advertisement.

The Prediction of Efficiency in Internal Combustion Engines

By WILLIAM D. ENNIS, Professor of Mechanical Engineering in the Polytechnic Institute of Brooklyn.

The efficiency of the internal combustion motors is predicted rather than to design and build the motor, and then find out how good it is. Comparison is made with the idealized Otto cycle. Basic formulæ are given and the workings of the same are exposed. Application to the design of the automobile type of motor is made.

AN advance estimate of the probable economy of a steam engine may usually be made on the basis of experimental data. Of these there are an abundance, for all sizes, types and forms of engine. A computation of probable efficiency on theoretical grounds is usually less satisfactory. The factor of cylinder condensation is so uncertain that in this respect alone the method must be based upon bold assumptions, the only justification for which is found in the records of those very tests which should enable us to form a more direct prediction.

With the internal-combustion engine the case differs. Here we have not only a comparatively insignificant number of test records, but with a few exceptions designs are so far from standardized that it is impracticable as yet to systematically classify those results which we do possess. Fortunately, a purely theoretical estimate is possible. In this, it is true, certain assumptions must be made; but the accuracy of our knowledge of these factors surpasses that which we have of the quantitative effect of such matters as condensation in the steam cylinder. Moreover, the error in the final result is of inferior order to those involved in most of the necessary assumptions.

Let an internal-combustion engine have a piston displacement of D cubic feet per minute; let it be supplied with a mixture of fuel and air in the proportions A and B, by volume, parts in 100. Then the volume of fuel supplied per minute is, in cubic feet,

$$0.01\,AD.$$

Referring to Fig. 1, which represents the idealized Otto cycle with the suction and exhaust strokes omitted, the cylinder is full of the mixture only along the line 4 1. We may readily calculate the specific volume of this mixture if the temperature and pressure at either 4 or 1 be given. We may also find, from the same data, the specific volume of the fuel, separately considered, at the pressure and temperature existing at any instant when the piston is at the outer dead center and the cylinder is filled with fluid. Let this specific volume (cubic feet occupied by 1 pound of vaporized fuel) be C.

In Fig. 2, let the stroke of the piston be from B to A and let the engine make E strokes per minute. If the piston displacement per stroke be F cubic feet, then

$$EF = D.$$

During each stroke the cylinder is filled with mixture of volume F, and of this mixture the vaporized fuel has the volume

$$0.01\,AF.$$

The weight of fuel trapped in the cylinder at each stroke is then

$$\frac{0.01\,AF}{C};$$

and the total weight of fuel supplied per minute is, in pounds,

$$\frac{0.01\,AFE}{C} = \frac{0.01\,AD}{C}. \qquad (1)$$

Let the heat of combustion of the fuel, per pound, be G, B.t.u.; then the heat chargeable to the engine, per minute, is

$$\frac{0.01\,ADG}{C}, \text{ B.t.u.} \qquad (2)$$

The next step is to find the amount of power exerted by reason of this supply of heat. The diagram of Fig. 1 may serve to represent the indicator diagram obtained from the engine, somewhat idealized. The lines 2 3 and 4 1 may be regarded as vertical, while 3 4 and 2 1 are of a form which may be represented by the equation

$$PV^n = \text{a constant},$$

in which the value of n varies with the piston speed, jacketing and other factors, but is, roughly, about 1.3. Taking the value of n the same for the curve 3 4 as for 2 1, the mean effective pressure of the diagram (average height of the area 1 2 3 4) is, in usual notation,

$$\frac{P_3V_3 - P_4V_4 - P_2V_2 + P_1V_1}{(V_1 - V_2)\,(n-1)} = H. \qquad (3)$$

Let the engine give E diagrams per minute. The work done, in foot-pounds, per minute, is

Mean effective pressure × *piston area* × *length of stroke* × *number of strokes.*

But *piston area* × *length of stroke* $= V_1 - V_2$, and $V_1 - V_2 \times$ *number of strokes* $= D$; while 778 foot-pounds $= 1$ B.t.u.; so that the work done per minute, in B.t.u., is

$$HD = \frac{D}{778\,(n-1)\,(V_1 - V_2)}\,(P_3V_3 - P_4V_4 - P_2V_2 + P_1V_1),$$

and the thermal efficiency, equal to the ratio of work done to heat supplied, is

$$I = \frac{DC}{7.78\,ADG\,(n-1)\,(V_1 - V_2)}\,(P_3V_3 - P_4V_4 - P_2V_2 + P_1V_1),$$

$$= \frac{C}{7.78\,AG\,(n-1)\,(V_1 - V_2)}\left\{(P_1 - P_4)\,V_1 + (P_3 - P_2)\,V_2\right\}$$

Thus far the steps are almost exactly correct: a slight corrective factor to include the effect of irregularities in the actual diagram being all that is necessary to make them strictly accurate. From this point, some assumptions must be made. For a given type of engine there is ample data to permit of fixing the probable value of P_1, the pre-compression pressure. For a given fuel, P_2 is also determined in the design, with considerable exactness. The only serious uncertainty has to do with the value of P_3. We have no complete data as to variations in maximum pressure attained with various forms of engine. So far as is known, the jacketing arrangements are the only controlling factors, and when these are such as to satisfy mechanical operative requirements, the temperature at the point 3 is not far from constant for all engines using hydrocarbon fuels other than producer gas or blast-furnace gas. The pressure P_3 then depends solely on the pressure and temperature at 2, in accordance with the law

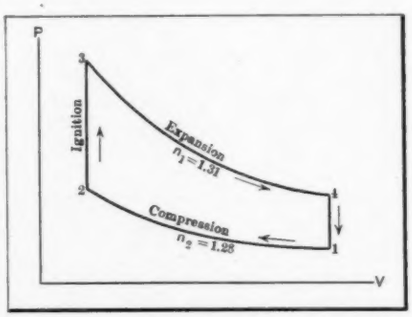


Fig. 1—Indicator diagram representing idealized Otto cycle

$$\frac{P_3}{P_2} = \frac{T_3}{T_2},$$

temperatures being absolute temperatures and ignition instantaneous. With P_2 and P_1 given, T_3, of course, depends upon the values of T_1 and the exponent n. Knowing P_3, we may find P_4 from the relation

$$\frac{P_4}{P_3} = \frac{P_3}{P_2},$$

an equation which holds only when the exponent n is the same for both the curves 3 4 and 2 1. But if $P_3V_3^m = P_4V_4^m$, we readily find

$$P_4 = P_3\left(\frac{V_3}{V_4}\right)^m$$

In order to find the volumes, we note that $P_1V_1^n = P_2V_2^n$, whence $\frac{V_1}{V_2} = \left(\frac{P_2}{P_1}\right)^{\frac{1}{n}}$.

Then $V_1 - V_2 = V_2\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - V_2 = V_2\left\{\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right\}$. This yields

$$I = \frac{C}{7.78\,AG\,(n-1)\,(V_1-V_2)}\left[(P_1-P_4)\,V_2\left\{\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right\} + (P_3-P_2)\,V_2\right]$$

$$= \frac{CV_2}{7.78\,AG\,(n-1)\,(V_1-V_2)}\left[P_2P_1^{\frac{n-1}{n}} - P_1 - P_4\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} + P_4 + P_3 - P_2\right].$$

It is usually more convenient to find the numerical ratio of V_1 to V_2;

$$V_1 = \left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} V_2 = \text{say } JV_2.$$

Then by substitution in the first formula for I, we find

$$I = \frac{CV_2}{7.78\,AG\,(n-1)\,(V_1-V_2)}\left\{J\,(P_1-P_4) + P_3 - P_2\right\}$$

$$= \frac{CK}{7.78\,AG\,(n-1)}\left\{J\,(P_1-P_4) + P_3 - P_2\right\},$$

in which $K = \frac{V_2}{V_1-V_2}$ is the *clearance*, expressed in proportion of the piston displacement. The analysis may be extended to cases in which the exponents of the expansion and compression curves have different values. A specimen calculation will show that the method is simpler when handled arithmetically than in symbols.

Application to an Automobile Engine

Let the fuel be gasoline, its composition being assumed to be C_6H_{14}, and its heat of combustion 22,000 B.t.u. per pound. Let the mixture consist of 38 parts of air to one of gasoline vapor, by volume (the theoretically correct amount of air would be about 46.7 parts), so that $A = \frac{100}{38+1} = 2.564$, $B = 97.436$. Let the engine be of the four-cycle, single-acting type; then P_1 may be assumed at about 12 pounds absolute, while T_1 in this class of service may be about 100 deg. F. or 560 deg. absolute. The pressure assumed is in pounds per square *inch;* all pressures will later be converted to pounds per square *foot*. The specific volume of air at any pressure and temperature is given by the formula

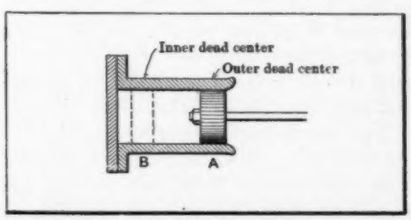


Fig. 2—Sketch indicating position of piston in cylinder at various stages of stroke

$$V = \frac{53.36\,T}{P},$$

which in this instance becomes

$$\frac{53.36 \times 560}{144 \times 12} = 17.29 \text{ cubic feet.}$$

Gasoline vapor is 3.05 times as heavy as air; its specific volume, at the moment when the mixture completely fills the cylinder, is then

$$17.29 \div 3.05 = 5.669 \text{ cubic feet.}$$

The weight of gasoline fed per cubic foot of piston displacement is then

$$\frac{0.01 \times 2.564}{5.669} = 0.004523 \text{ pound,} \qquad \text{(Equation 1)}$$

and its heat of combustion is (Equation 2)

$$0.004523 \times 22{,}000 = 99.506 \text{ B.t.u.}$$

Tests have shown for the type of engine in question that the value of n for the compression curve 1 2, Fig. 1, may be taken at about 1.28; that for the expansion curve 3 4 may be taken at 1.31. Calling these values n_2 and n_1, the mean effective pressure is given by an expanded form of Equation 3 as

$$H = \left\{\frac{P_3V_3 - P_4V_4}{n_1 - 1} - \frac{P_2V_2 - P_1V_1}{n_2 - 1}\right\} \div (V_1 - V_2).$$

Since $P_1 = 12$, and P_2 in a gasoline automobile engine may be fixed at 75, we find

$$P_1V_1^{n_2} = P_2V_2^{n_2}\ V_2 = \left(\frac{P_1}{P_2}\right)^{\frac{1}{n_2}} V_1 = \left(\frac{12}{75}\right)^{0.781} V_1 = 0.239\,V_1.$$

We then reduce Equation 3 as follows:

$$H = \left\{\frac{P_3V_3 - P_4V_1}{n_1 - 1} - \frac{P_2V_2 - P_1V_1}{n_2 - 1}\right\} \div (V_1 - V_2)$$

$$= \left\{\frac{0.239\,P_3V_1 - P_4V_1}{n_1 - 1} - \frac{0.239\,P_2V_1 - P_1V_1}{n_2 - 1}\right\} \div (0.761\,V_1).$$

To evaluate this, we may assume the maximum temperature T_3 to be about 3,000 deg. absolute (2540 deg. F.). Then

$$\frac{P_3}{P_2} = \frac{T_3}{T_2} \text{ and } P_3 = 75 \times \frac{3{,}000}{T_2}.$$

But by a common law of gases,

$$P_2V_2T_1 = P_1V_1T_2;$$

also

$$P_2V_2^{n_1} = P_1V_1^{n_1}.$$

Combining these two forms,

$$V_2^{1-n_1}T_1 = V_1^{1-n_1}T_2$$

$$\left(\frac{V_2}{V_1}\right)^{1-n_1} = \frac{T_2}{T_1}$$

$$T_2 = T_1\left(\frac{V_2}{V_1}\right)^{1-n_1} = 560\,(0.239)^{-0.28} = 836 \text{ deg. absolute.}$$

Substituting, we find

$$P_2 = 75 \times \frac{3{,}000}{836} = 269.5 \text{ pounds per square inch.}$$

Again,

$$\frac{P_4}{P_1} = \frac{P_3}{P_2},\ P_4 = P_1 - \frac{P_3}{P_2} = 12 \times \frac{269.5}{75} = 43 \text{ pounds per square inch.}$$

The numerical value of H, the mean effective pressure, is then

$$\left\{\frac{(0.239 \times 269.5) - 43}{0.31} - \frac{(0.239 \times 75) - 12}{0.28}\right\} \div 0.761$$

$$= 62.2 \text{ pounds per square inch.}$$

The same value multiplied by 144 (to reduce to pounds per square *foot*) represents the work done by the engine, in foot-pounds, per cubic foot of piston displacement, and the thermal efficiency is consequently

$$I = \frac{62.2 \times 144}{778 \times 99.506} = 0.1157.$$

Suppose the automobile to be developing an average continuously of 20 horsepower at the cylinder and to be moving at a speed of 22 miles per hour, its rate of work performance will then be $\frac{20}{22} = 0.91$ horsepower-hours per mile. One horsepower-hour is equivalent to

$$\frac{33{,}000 \times 60}{778} = 2{,}545 \text{ B.t.u.}$$

The heat equivalent of the power exerted is then

$$2{,}545 \times 0.91 = 2{,}316 \text{ B.t.u. per mile,}$$

and the consumption of gasoline should be

$$\frac{2{,}316 \div 0.1157}{22{,}000} = 0.91 \text{ pound per mile;}$$

or the machine should travel, with one gallon (5 5-8 pounds) of gasoline,

$$\frac{5\ 5\text{-}8}{0.91} = 6.23 \text{ miles.}$$

Changing the Mixture

Suppose now that by adjustment of the carbureter the engine were given a more nearly correct mixture, say, 44 parts of air to one of gas, so that

$$A = \frac{100}{44+1} = 2.213, \quad B = 97.787.$$

The weight of gasoline fed per cubic foot of piston displacement is, then,

$$\frac{0.01 \times 2.213}{5.669} = 0.00391 \text{ pound,} \qquad \text{(Equation 1)}$$

and the heat of combustion chargeable is

$$0.00391 \times 22{,}000 = 86.1 \text{ B.t.u.} \qquad \text{(Equation 2)}$$

If no change be made in our assumption as to maximum pressure, P_3, the mean effective pressure is as before 62.2 pounds per square inch. Theory would warrant the assumption of a higher pressure, P_3, when the air supply is more nearly correct, but in the absence of data in verification of this, we may take the mean effective pressure as certainly not less than 62.2, and the thermal efficiency becomes

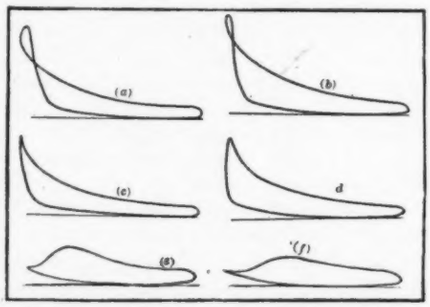


Fig. 3—a, ignition 25 per cent. early; b, ignition 20 per cent. early; c, ignition 16 per cent. early; d, ignition 12 per cent. early; e, ignition 5 per cent. early; f, ignition 10 per cent. late*

$$> \left[\frac{62.2 \times 144}{778 \times 86.1} = 0.134 \right].$$

This would make the miles run per gallon of gasoline, under the assumed speed and load conditions, 7.2 instead of 6.23; the efficiency varying directly, and the gasoline consumption inversely, as the proportion of gas in the mixture. As has been stated, this is within the fact.

Altering the Spark

The wastefulness arising from an incorrect spark position is suggested in Fig. 3, which represents the indicator diagrams obtained for various points of ignition. In a, ignition occurs when the piston has only three-fourths completed its return stroke (from A toward B, Fig. 2). In b the spark is a little later, and in c later still. The correct position seems to be attained in d. Here ignition occurs when the return stroke is seven-eighths completed. In e, and more notably in f, ignition is too late; the spark passes after the piston has passed the inner dead center. The area of the indicator diagram is thus much reduced, and since this area represents the work done by the engine, a serious loss of power results. If the engine, when giving the diagram d, with the spark properly adjusted, develops 20 horsepower, it will, when giving the diagram a, develop only 16 horsepower, and the horsepower for diagram f will be only 15. Every variation of the spark from position d decreases the amount of power developed. These decreases, moreover, are *unaccompanied by any decrease in the amount of fuel supplied.* Moving the spark from the ideally correct position is, therefore, always wasteful. Suppose the spark is shifted from position d to position a. The car will no longer make 6.23 miles per gallon of gasoline, but only

$$6.23 \times \frac{16}{20} = 4.86 \text{ miles,}$$

a decrease of 22 per cent.

* From Poole's "The Gas Engine," by permission of the Hill Publishing Company.

Throttling

In the ideal cycle of an internal-combustion engine the curves 3 4 and 2 1, Fig. 1, are *adiabatic*, i. e., there is no transfer of heat to or from the mixture while it is working along those curves. In such case, the ideal efficiency is, l standing for the specific heat at constant volume,

$$\frac{l(T_3 - T_4) - l(T_2 - T_1)}{l(T_3 - T_2)} = 1 - \frac{T_4 - T_1}{T_3 - T_2}.$$

But $\frac{T_4}{T_3} = \frac{T_1}{T_2}$, as already found; hence, $\frac{T_4}{T_1} = \frac{T_3}{T_2}$, $\frac{T_4}{T_1} - 1 = \frac{T_3}{T_2} - 1$,

$\frac{T_4 - T_1}{T_3 - T_2} = \frac{T_1}{T_2}$, and the efficiency is

$$1 - \frac{T_1}{T_2} = \frac{T_2 - T_1}{T_2}.$$

Since $\frac{P_2V_2}{T_2} = \frac{P_1V_1}{T_1}$, while $P_2V_2^n = P_1V_1^n$ and $P_2^{\frac{1}{n}}V_2 = P_1^{\frac{1}{n}}V_1$,

we may write

$$\frac{\frac{P_2V_2}{T_2}}{P_2^{\frac{1}{n}}V_2} = \frac{\frac{P_1V_1}{T_1}}{P_1^{\frac{1}{n}}V_1} \text{ and } \frac{P_2^{1-\frac{1}{n}}}{T_2} = \frac{P_1^{1-\frac{1}{n}}}{T_1}, \text{ or } \frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}}.$$

Also,

$$\frac{\frac{P_2V_2}{T_2}}{P_2V_2^n} = \frac{\frac{P_1V_1}{T_1}}{P_1V_1^n} \text{ and } \frac{V_2^{1-n}}{T_2} = \frac{V_1^{1-n}}{T_1}, \text{ or } \frac{T_1}{T_2} = \left(\frac{V_1}{V_2}\right)^{1-n}.$$

The efficiency may then be written

$$1 - \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}} \text{ or } 1 - \left(\frac{V_1}{V_2}\right)^{1-n}$$

It thus depends upon the range of pressure or of volumes during compression and on the value of n.

Now in the actual engine, the curves 3 4 and 2 1 are not adiabatic; the mixture is giving up or receiving heat to the cylinder walls at a rate which is determined by the values of n and the temperature ranges. The heat received along 3 4, in spite of a higher value of n, exceeds that rejected along 1 2, because the temperature range is two or three times greater. The efficiency is thus less than that of the ideal cycle, but the following analysis for the ideal cycle is found to correspond with the results actually attained.

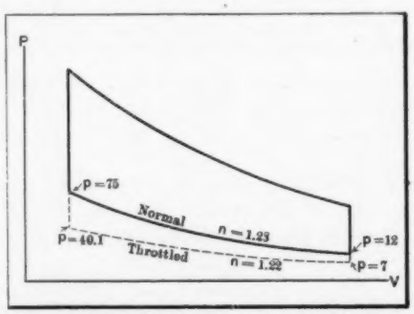


Fig. 4—Normal diagram with dotted lines showing effect of throttling

In an engine once constructed,

the value of $\frac{V_1}{V_2}$ is for all time fixed, and if the value of n were also fixed, the efficiency would be constant for all mixtures and pre-compression pressures. It would be independent of the load. But in practice we find the efficiency to decrease at light loads. There is trapped in the cylinder clearance space (which may be as much as 50 per cent. of the piston displacement) at all times a volume of mixture which at each stroke mingles with the fresh charge. This clearance mixture is hot, hotter not only than the fresh charge, but also hotter than the jacketed cylinder walls. When the suction is throttled, the proportion of fresh charge to clearance gas (by weight) is decreased. The whole mixture is, therefore, hotter than it otherwise would be. It consequently loses more heat to the cylinder walls during the compression stroke than it otherwise would lose. Its pressure and temperature at any moment are then less than they otherwise would be; the compression curve is, therefore, a flatter curve, i. e., the value of n is reduced. In the expressions,

$$\frac{T_2 - T_1}{T_2}, \quad 1 - \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}}, \quad 1 - \left(\frac{V_1}{V_2}\right)^{1-n}$$

the effect of throttling is to decrease the efficiency. Fig. 4 shows the normal and part of the throttled indicator diagrams superimposed, the latter being dotted. Without considering, for the present, the modifications which might arise as the result of throttling on the upper part of the diagram, let us examine the cases in which (a), as in our former illustration, $n = 1.28$, $P_1 = 12$, $\frac{V_2}{V_1} = 0.239$; and (b) $n = 1.22$, $P_1 = 7$, $\frac{V_2}{V_1} = 0.239$. In the former case we have found that $P_2 = 75$, and the ideal efficiency is

$$\frac{836 - 560}{836} = 0.33; \quad 1 - \left(\frac{12}{75}\right)^{0.219} = 0.33; \quad 1 - (4.19)^{-0.28} = 0.33.$$

In the latter case, the efficiency becomes

$$1 - (4.19)^{-0.22} = 0.27;$$

or, since

$$P_2 = P_1\left(\frac{V_1}{V_2}\right)^n = 7\,(4.19)^{1.22} = 40.1,$$ we may also write the efficiency as

$$1 - \left(\frac{P_1}{P_2}\right)^{\frac{n-1}{n}} = 1 - \left(\frac{7}{40.1}\right)^{0.18} = 0.27.$$

The ideal efficiency is thus decreased 6 per cent. by throttling; the miles run per gallon of gasoline, assuming that the actual efficiency is correspondingly decreased, would drop from 6.23 to

$$6.23 \times \frac{94}{100} = 5.85.$$

Summary

It is thus possible to predict not only the normal efficiency, but also that attained under modified conditions of mixture, spark position and throttle opening. The importance of a proper mixture and the economy of a wide-open throttle are shown, and the wastefulness resulting from unnecessary adjustment of the spark is clearly illustrated.

Vogue of Small Automobiles in Europe

By W. F. BRADLEY

The economical figure for automobiles in Europe seems to be $500; the commercial traveler and the doctor use the diminutive car; single-cylinder motors are preferred; the stroke is relatively long; belt-drive shown in one instance; simplicity is regarded as a companion to convenience of location in these types of cars.

WITH a view to bringing out the trend of the industry in France and England, resort has been had to the camera, and among the illustrations here afforded is ample evidence of the manner in which the question of economy is coupled with utility.

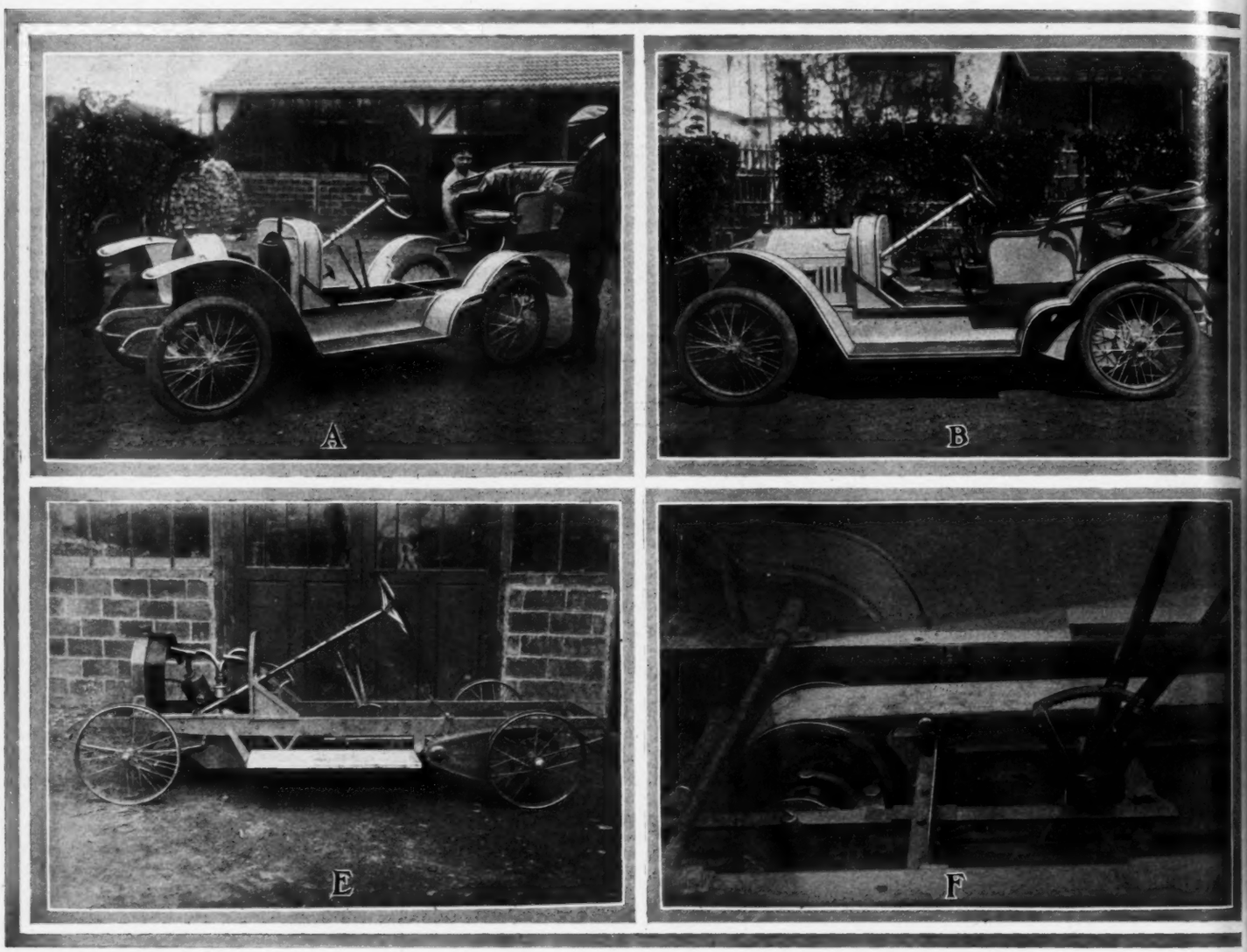
Both France and England are keenly interested in the economical automobile. The economical figure for the European is $500, or not more than $600, all complete for the road. And for this moderate price the Easterner wants something more than a toy; his automobile must be capable of carrying two persons at a fair clip; it must be simple, reliable, cost little to maintain, and, in externals, at any rate, conform to established big car lines. There have been numerous attempts to fill the difficult position, and although some of the designs have been good, they have generally failed through indifferent construction, or by inattention to details.

One of the most promising of these diminutive automobiles intended for the commercial traveller, the doctor, and the man who cannot afford to run a big car, is the Forster, produced by an Englishman resident in France. The automobile, which can be marketed complete for a fraction over $500, has an armored wood frame giving a wheelbase of 84 inches and a track of 40 inches. It is mounted on wire wheels, shod with 700 by 85 tires, has semi-elliptic springs all round, the motor is carried under a bonnet forward, with the gilled tube radiator directly over the front axle, the gasoline tank is on the dash, oil tank under the bonnet, and, so far as its external appearance is concerned, is as graceful a vehicle as any large car yet produced.

There is nothing distinctive about the power plant: on the ordinary models it is a single-cylinder 7-horsepower Anzani or Aster, and on the semi-racing type a two-cylinder Anzani of 15-horsepower. The motor is placed across the chassis, thus making it necessary to crank from one side; the cranking handle is entirely hidden from view. This disposition of the motor is necessary on account of transmission by belt. A broad pulley is carried on the motor shaft and connection made by a long belt with the countershaft, providing two forward speeds and neutral, with final drive taken by single side chain running in an oil-tight casing. There is no clutch, no differential and no gearbox, as that organ is generally understood.

The driver declutches by means of the usual type of pedal, but this operation results in sliding forward the whole of the rear axle, thus slackening off the belt. The necessary movement of the axle is obtained by the use of long spring shackles hanging from a transverse tube projecting from each side of the chassis frame. This length of shackle allows the whole of the axle to be moved ahead far enough to free the belt. Naturally the countershaft has to move with the axle, so that the tension of the chain is never varied, and for further facility the change-speed lever and brake lever are also carried ahead, being mounted on the same frame as the countershaft. As the brake lever operates the rear-wheel brakes through cables it does not become inoperative with the changing position of the axle, the same relative distance always being maintained. Advantage is taken of this movement of the rear axle and countershaft to obtain a very simple brake. Immediately ahead of the driven pulley is a wooden brake block mounted to two transverse frame members. As it is moved forward, still driven by the road wheels and single chain, the pulley is brought in contact with this block and a braking effort obtained in proportion to the pressure exerted on the pedal.

A complete under-pan assures the belt working under ideal conditions; a plank placed immediately under its upper length causes it to drop away from the pulleys on "declutching," and the absolutely oil and dust-proof chain case gives complete protec-



A—Forster light car. Body can be lifted off in 10 seconds without any tools

B—Forster light car, in complete touring trim, as delivered to a Paris doctor

E—Racing type of Forster light car. Stripped chassis. Capable of 50 miles an hour.

F—Forster light car. Belt drive and two-speed gear. Final drive by single side chain

tion to all moving parts. As a matter of fact, there is less exposure to dust and moisture on this cheap little car than on many a $5,000 production. There are only two speeds, obtained by two dog clutches on the countershaft, the high gear giving a direct drive through from the motor to the locked countershaft, and the second clutch giving a suitable reduction. Ball bearings are used everywhere except in the motor; that is to say, on the four road wheels and in the countershaft, the only moving parts. There is no reverse, this not being required under the French law for a car weighing not more than 770 pounds; but in view of the added convenience the designer is about to fit one, to be worked off the same lever.

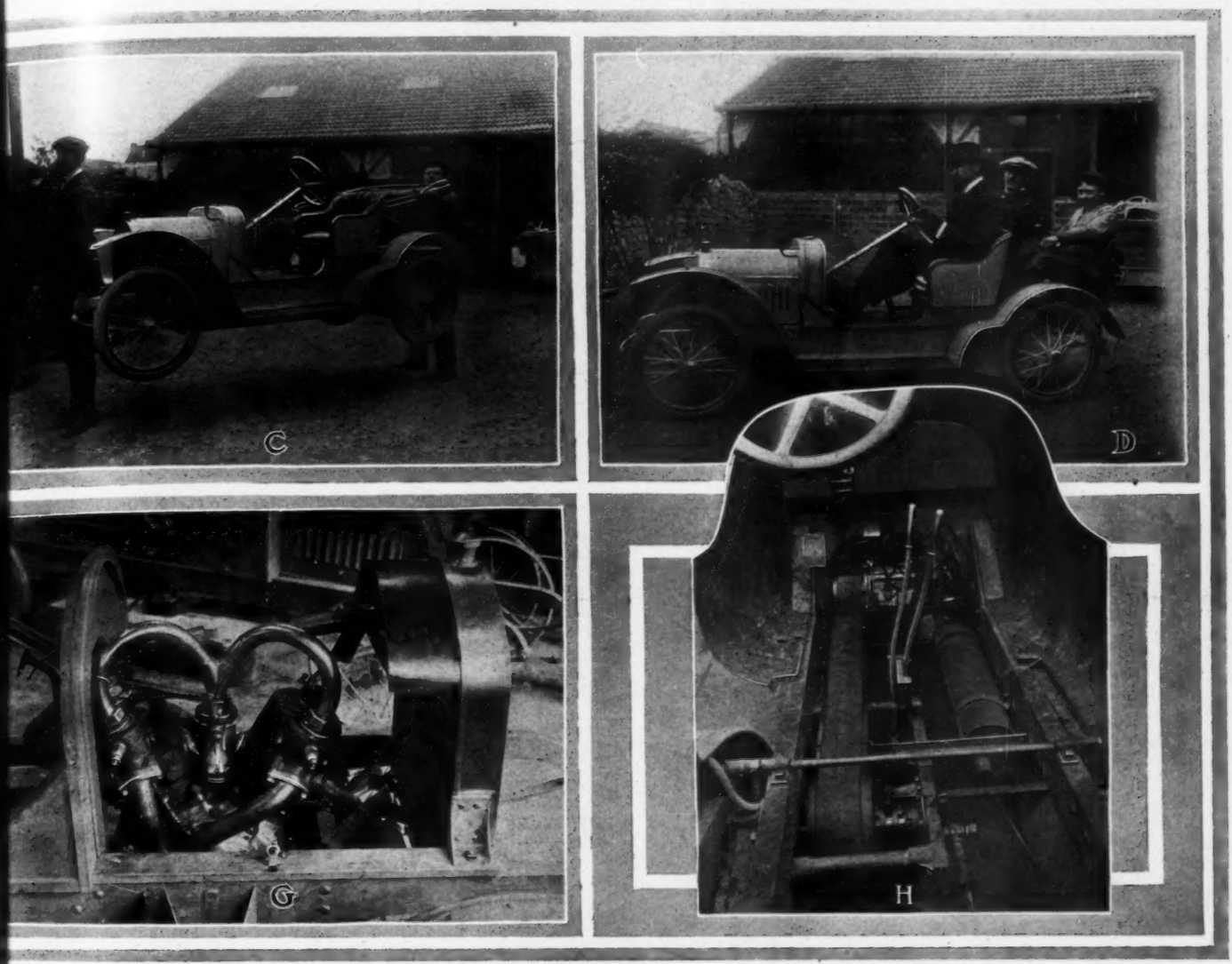
Speed is only a question of the motor and the most suitable gearing, the belt being able to take care of any power. On the standard model, with the 7-horsepower one-lunger, 30 miles an hour can be maintained on the level. With the two-cylinder Anzani and a change of the driving sprocket, the car can do well over 50 miles an hour on the level. For this fast work the bonnet is made lower than usual, the steering column is more inclined and longer, with a very large wheel, for there is no gearing between steering wheel and road wheels.

A 40-inch track leaves little room for two seats side by side, and with a view to comfort the designer of the car has placed the passenger's seat a little to the rear of that occupied by the driver; thus the elbows of the one do not interfere with the other. There is even a third folding seat in the rear, but as this is not intended to be regarded as such by the French fiscal authorities, it is folded away except when wanted for emergency passenger carrying. As a try-out of his car, the designer undertook a three weeks' trip through Algeria, which might be considered as the European equivalent of a coast-to-coast run. He came back convinced that he had got hold of the right idea for a light, speedy, and economical car.

Two models are produced, one with the steering wheel on the left and levers in the center, for countries where the rule of the road is the same as in America, and another one with the wheel on the right, for use under the English rule of the road.

Large Flywheel Used on Small Motors

It will be understood that flywheel effect is as necessary as the motor from a certain point of view. Not so long ago it was the choice of a certain class of designers to reduce weight of the flywheel to the greatest possible extent, and in six-cylinder motors it was claimed that almost no flywheel effect is necessary. Experience has shown that a large flywheel is efficacious as a power storage medium, and that it has a value over and above the mere matter of helping the motor to complete its cycle.



C—Forster light car. Weighs about 770 pounds, all included

D—Forster light car. Room for a third person at the rear

G—Forster light car, with this two-cylinder Anzani motor, can do 50 miles an hour

H—Forster light car, showing belt transmission and final drive by single side chain

Valve Action and Other Influences for Efficiency

MANY autoists find that the cars they drive after they run for a time become mysteriously unruly, and, despite their earnest effort, fail to respond to the remedies applied. When a motor shows evidence of weakening, the autoist immediately arrives at the conclusion that his ignition system is out of order, because to him there is more mystery in an ignition system than in anything else, and his reasoning power becomes befogged by the weight of negative evidence thus afforded. If, in the course of investigation, the autoist is able to determine to his own satisfaction that the ignition system is in good working order, his attention next lights on the carbureter, and if after "tickling" the same to make it spew an excess of gasoline, the process does no good, it is in order to tamper with the adjustments long enough to make sure that the automobile will not run at all.

Strength of Valve Springs Must Be Watched

It would be more to the point to find out if the parts are all present, and if they are properly related to each other. A wobbling joint, or a nut lost off of a bolt head, or a dozen and one other mechanical derangements, including a plugged-up passage-way, might account for all the trouble, but there are other possibilities that are harder to find, hence the mystery in many cases.

Few indeed are the problems that have to be solved that are more troublesome to the operator of a car than the one involving the strength of the valve springs. If they are too strong, the cams and lifts will be damaged too soon, but if they are not strong enough, the timing will get out of order. It is not generally recognized that timing a motor is only a partial process, on account of the fact that the mechanism is only positive in one direction. True, the cam lifts the valve off of its seat at a set time, but the spring placed to close the valve is not positive. If the spring is "lazy" the angular rotation of the camshaft will be increased to excess before the valve will be pressed against the seat. On account of the structural changes that springs undergo it is impossible to so design them that they will be just right for the work to be done all the time, and it is the practice among makers to employ over-strong springs in new motors, with the expectation that they will never weaken to a point where they will fail to serve for the purpose.

The chances are that the pressure should be about 40 pounds per square inch between the valve and the seat, and that it will remain so at all times is highly improbable. If the spring is

strong enough to withstand the work without mechanical or structural deterioration independent of the effect of heat, it only remains to so place the same that its temper will not be drawn by the heat. Unfortunately springs are required to work up to the limit of their fiber ability, and they are likely to undergo some change from this account. Then the heat is enough in many examples to anneal the metal so that some weakening is to be expected from this cause.

It would be good work were the springs placed to close valves capable of doing so within a rotation of 20 degrees of the camshaft. The angular travel of the camshaft is frequently more than 40 degrees. The method of calculating for this angle is given as follows:

Let,

θ — Angle of camshaft rotation during the closing of the valve under the action of the valve spring.

S — Speed of the camshaft in revolutions per minute.

W — Weight of valve in pounds.

P — Mean pressure of the spring in pounds.

l — Lift of the valve in inches.

When,

$$\theta = \sqrt{\frac{l\,(S\,W)^2\,W}{0.67\,P}}$$

While noise is the normal expectation if the spring does not work properly, it is believed that the most noise comes from weak springs rather than when the pressure is excessive. To withstand the pressure the parts, as the roller, pin, cam-face and ends of the rods, must be of close-grained metal and well hardened—this is not always the case.

Altitude Influences Radiator Action a Little

The factor of safety required in a radiator for an automobile must be subdivided (a) from the mechanical strength point of view, and (b) considering the capacity of the radiator to do the work required of it. The condition (a) is not easy to settle; experience will have to be the guide to a large extent. That the radiator should be flexibly mounted is one of the settled conditions. The question of capacity and the margin to allow against unusual demands, is capable of being disposed of to quite some extent. Altitude, for illustration, has its effect as follows:

BOILING POINT OF WATER AT VARIOUS ALTITUDES.

Feet Above Sea Level	Boiling Point in Deg. F.
Sea Level	212
1,025	210
2,063	208
3,115	206
4,169	204
5,225	202
6,304	200
7,381	198
8,431	196
9,579	194
10,685	192

Sediment and incrustation also have to be allowed for, and the chances are that radiators will depreciate in ability about 33 per cent. within a single year. This depreciation will probably reach a maximum within the stated time, excepting in the cases where lack of attention is at the bottom of the trouble. There is no way of determining what to allow for such cases. Radiators that do not "steam" will surely reach a stable level if the water used is reasonably free from foreign substances. So little water will have to be added in a year that all the sediment that can get into them will be very limited. Unfortunately, a very slight coating of sediment or scale will have a large effect, and 33 per cent is a fair allowance.

In filling a radiator it is wrong to supply so much water that there will be no free space; water swells when it is heated in a cooling system, owing in part to the increase in the temperature, but for the most part owing to the presence of steam.

New Two-Cycle Motor with Rotary Intake Valve

By W. F. BRADLEY

A prominent French engineer, Georges Deloche, is responsible for the design of the two-cycle motor here illustrated; it has four vertical cylinders with copper water jackets; ignition is by high tension magneto; the crankshaft has five bearings; exhaust ports are uncovered by the piston on the down stroke; the peculiarity of the motor is due to the use of rotary valves carried in the position usually occupied by the camshaft.

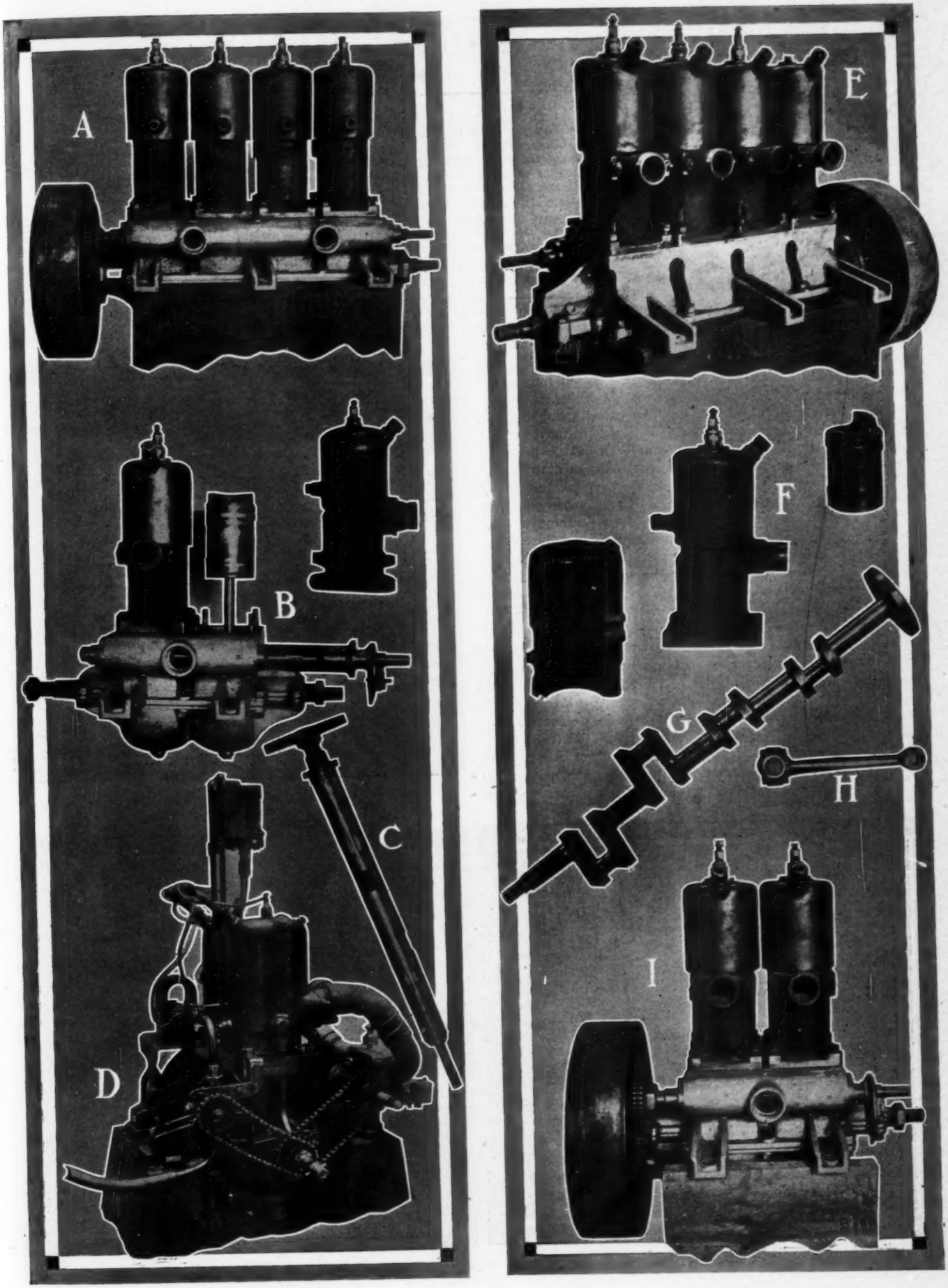
INTEREST in two-cycle motors, while it has been tame at times, persists, nevertheless, and the impetus which has been given rotary types of valves of late is having its influence upon the two-cycle motor quite as much as it modifies the ideas which are dominant in connection with four-cycle efforts. A two-cycle motor with a rotary intake valve has been placed on the market by the French engineer, Georges Deloche. In all but one feature the motor conforms to standard practice. It has four vertical cylinders of 3.9 inches bore and 5.5 inches stroke, with copper water jackets, pump circulation, ignition by high-tension magneto, a five-bearing crankshaft and exhaust through a port uncovered by the piston at the end of its downward course.

The peculiarity of the motor is that a rotary valve is carried in the position usually occupied by the camshaft on a four-stroke motor, and like this, is driven by spur gears from the main shaft. The rotary valve is a rather large-diameter hollow shaft, provided with six openings or ports. Two of these extend entirely round the circumference of the shaft, leaving just the necessary amount of metal required for strength, while the four others are of smaller dimensions. The two large openings communicate with the intake piping and at all times provide a free opening from the carbureter to the interior of the shaft. The four smaller openings each correspond with an intake port, admitting to the interior of the four separate crankcase divisions. On the upstroke of the piston the openings in the rotary valve correspond with the intake ports, allowing a charge to be drawn in through the hollow shaft and compressed within the crankcase against the closed valve, on the downward course of the piston. As in the majority of two-stroke motors, a by-pass is provided, by which the charge already compressed in the crankcase can be passed into the combustion chamber on the port being uncovered as the piston nears the end of its stroke.

The same principle applies to a two-cylinder model, the rotary valve in this case, however, having but three openings, one in constant communication with the carbureter, and the two others giving admission into the crankcase division at each revolution. On the single cylinder model the inventor makes the crankshaft fulfill the functions of rotary valve. The shaft is hollow, and is cut away for a portion of its circumference to give a free opening from the intake pipe; the charge passes through an intake port in the crankcase, to the interior of the case, where compression takes place on the downward stroke of the piston.

In the illustrations on the opposite page, A shows the Deloche 4-cylinder, 2-cycle motor, with intake ports and rotary valve; B, the same, with cylinder dismounted and rotary valve partially withdrawn; C, rotary valve; D, 2-cylinder, 2-cycle motor of same make; E, 4-cylinder, 2-cycle motor, exhaust side; F, cylinder and piston of same; G, crankshaft; H, connecting rod; I, side elevation of the 2-cycle motor.

There is no doubt about the desire on the part of French designers to travel in the direction of simplicity, and the great aim beyond the matter of ease of repair lies in the high cost of fuel. Small motors, then, are looked upon with a longing eye, and they favor the two-cycle plan.


A
B
C
D
E
F
G
H
I

Foreign Armies Quitting the Horse

By W. F. BRADLEY

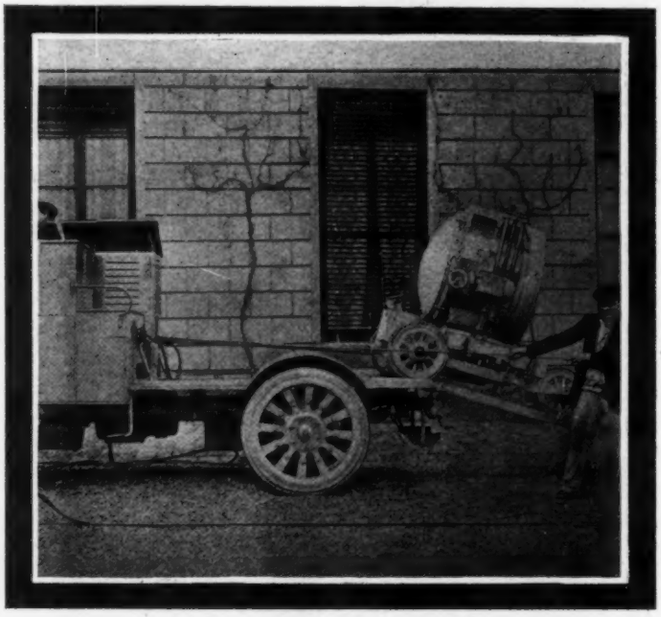
Horse-drawn vehicles being abandoned for searchlight equipment transportation; generating plant consists of dynamo and a gasoline motor to drive it; searchlight comprises another unit; chassis rolls on solid rubber tires; pneumatic control of the searchlight eliminates some troubles; projectors may be removed to ground in some models; methods for convenience and quick action shown.

ARMY organizations in Europe are keyed up to the highest pitch all the time, and the earnestness with which the automobile is taken advantage of there is a matter which may well be looked into in this country, not only on account of the advantages offered in the way of better military efficiency, but in view of the attraction which a new field has for the makers of automobiles.

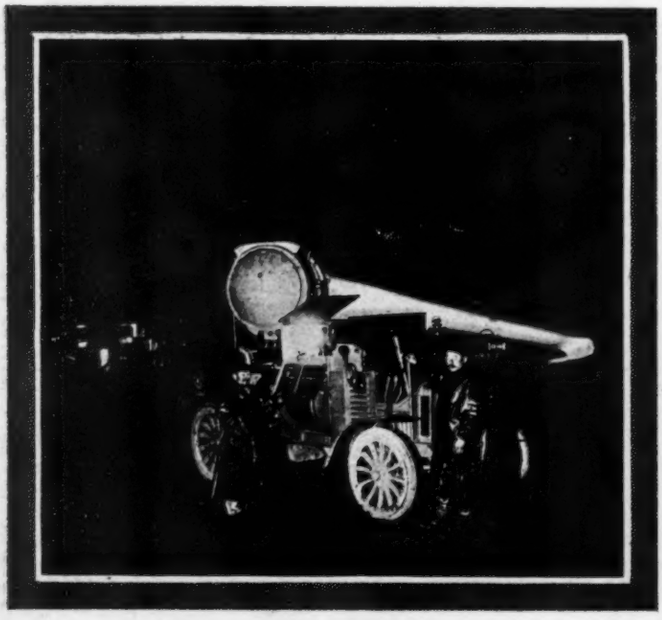
The horse has had to give way to the motor in another branch of army work. Up to the present, portable searchlights have been carried on horse-drawn vehicles, the generating plant, consisting of a gasoline motor and dynamo forming one unit, and the searchlight forming another and independent outfit. Each unit was carried on a separate vehicle. To be put into service the two units had to be connected, obviously, with a certain loss of time; and they could never send an investigating flash of light across the country when the vehicle was in movement on the highway. Even with six horses for each vehicle the outfit was not moved with all the rapidity that could be desired.

In future French troops will use a motor-driven searchlight, of a model produced by the De Dion Bouton Company and the Breguet concern, and officially adopted after searching tests by the staff officers. There is now no possibility of a failure owing to one of the vehicles getting astray, for the electricity producing plant and the projector form one unit and are self-propelled. The automobile portion of the apparatus consists of an 18-horsepower De Dion chassis suitably strengthened for the work it will have to perform, and fitted with a four-cylinder motor carried under the driver's feet. The chassis is mounted on single solid rubber tires in front and twin solids in the rear. The gear set gives three speeds forward and reverse, with a maximum of 20 miles an hour under full load on a level highroad, and an ability to climb grades of 15 per cent. Gasoline consumption works out at the rate of 10 miles to the gallon. Drive is taken through plate clutch, three-speed gear box and transverse cardans to the road wheels. Besides the rear wheels the motor also drives the dynamo mounted on the main shaft, either with the vehicle in motion or in a stationary condition. The entire electric outfit is arranged immediately to the rear of the driver's seat, the electrician sitting with his back to the driver, and in this position having in hand the entire control of the searchlight.

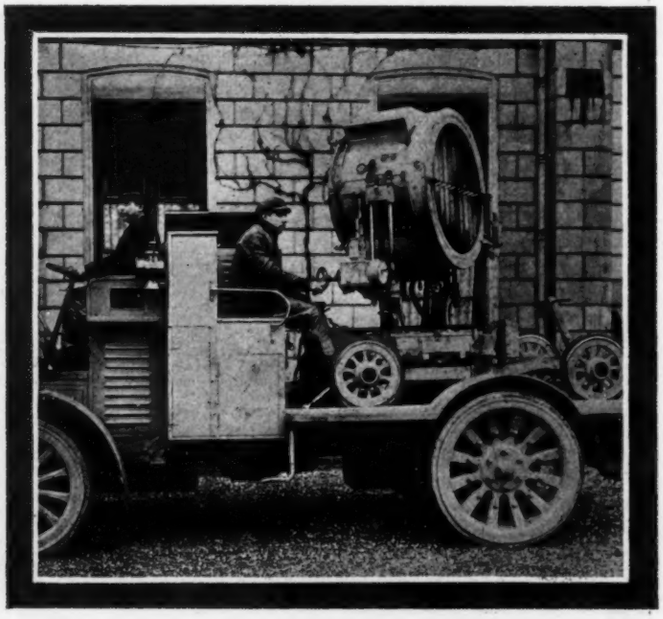
Three-quarters of the body area to the rear of the driver is left free to receive the searchlight, a Breguet instrument, the reflector of which has a diameter of 36 inches and flashes a light equal to 7,000 Carcel lamps. The projector is carried on two spring-supported forks attached to a circular track, thus allow-



Lowering the searchlight from automobile truck



French army automobile searchlight in action

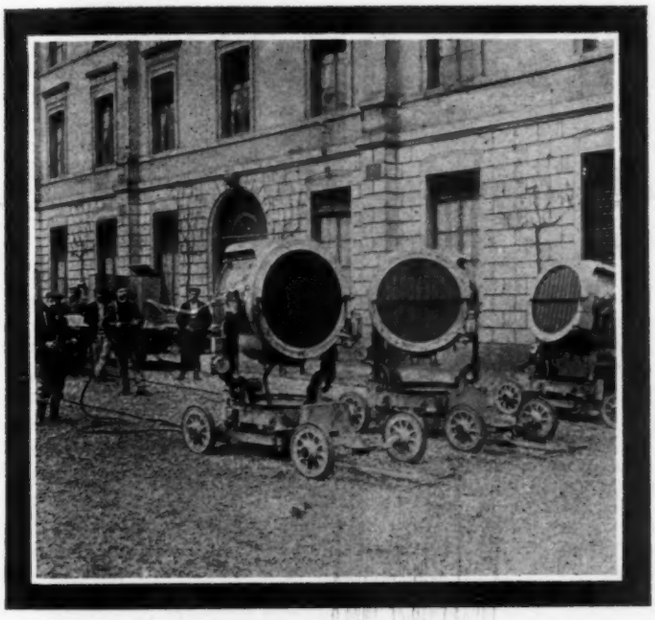


Projector raised in position for operating on the road

ing for free movement in every direction. The carriage is mounted on a four-wheeled bogie, the front wheels of which are pivotable and the whole specially designed to be received on the platform of the truck. When not in use the projector is lowered until it is well within the carriage, thus keeping the center of gravity low. If the projector is to be used on the road, it can be quickly raised by hand and the glare of the lamp flashed on any object even with the vehicle in motion.

When the automobile has been brought to a stop, the 18-horsepower motor is used exclusively for driving the dynamo. The apparatus may be operated either from the platform of the truck or with the projector taken down to the ground. The operation is a simple one, requiring the services of two men only; by means of an inclined platform attached to the rear of the truck, the bogie is run down to the ground under the control of a hand-operated winch. The electric cable supporting the current is wound on a drum, and on the projector being brought to the ground is automatically unwound for a maximum length of 100 yards, thus allowing the searchlight to be maneuvered into the most favorable position for operating while the motor continues to drive the dynamo only.

As the operation of a powerful searchlight at close quarters is very trying for the eyes, the instrument has been provided with a system of pneumatic control allowing the projector to be turned in any direction or placed at any angle while the operator is 15 to 20 yards in the rear. When the operator is working the searchlight from the motor vehicle the control is direct and by hand.



Projectors in position for operation. Compressed air control

Information About Air for the Autoist

(1) To find the quantity of nitrogen by volume corresponding to one volume of oxygen, multiply by 3.77092.

(2) To find the quantity of oxygen by volume corresponding to one volume of nitrogen, multiply by 0.265182.

(3) To find the quantity of nitrogen by weight corresponding to one part by weight of oxygen, multiply by 3.313022.

(4) To find the quantity of oxygen by weight corresponding to one part by weight of nitrogen, multiply by 0.301839.

(5) To find the quantity of nitrogen by volume corresponding to one part by weight of oxygen, multiply by 2.6365411.

(6) To find the quantity of oxygen by volume corresponding to one part by weight of nitrogen, multiply by 0.2730071.

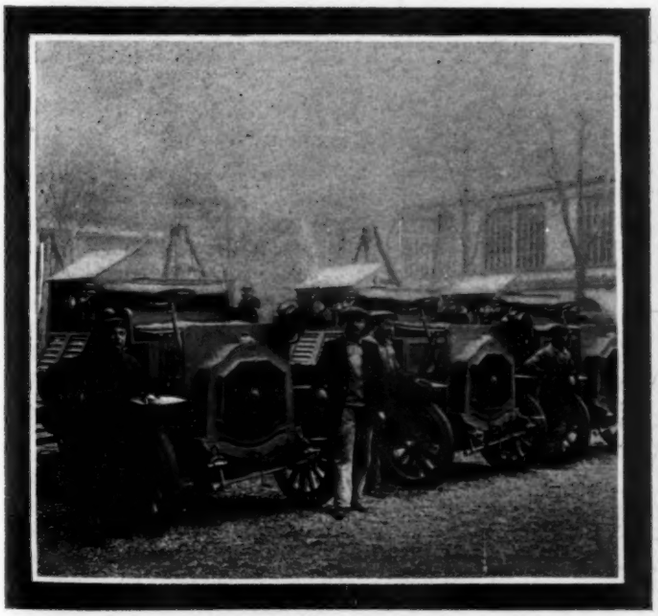
(7) To find the quantity of nitrogen by weight corresponding to one part by volume of oxygen, multiply by 3.6629154.

(8) To find the quantity of oxygen by weight corresponding to one part by volume of nitrogen, multiply by 0.3792848.

Producer-Gas Offers Certain Promise

In a certain class of freighting work involving the use of tractors and a train of cars, it is just possible that producer-gas will take the place of gasoline. The average gas of this character from anthracite coal has a thermal value of about 135 British thermal units of heat, and the various constituents by volume are:

Carbon dioxide, CO_2, 6 per cent. Carbon monoxide, CO, 24 per cent. Hydrogen, H, 15 per cent. Nitrogen, N, 55 per cent. Hydrocarbon, CH_4, trace. Oxygen, O, trace. Producers may be made in quite compact form and the fuel required per hundred miles of travel is not so much that it would more than serve as ballast for the tractor.



Army automobile searchlight trucks

Night photograph of French army automobile searchlight in action

Characteristics of Automobile Gasoline Frequently Disregarded

BEFORE gasoline can be used as fuel it must be vaporized. To produce vapor there must be an exchange of heat which will be at least equal to the latent heat of evaporation of the liquid. If the liquid is composite in nature, the latent heat of evaporation of the respective distillates must be considered. In any further effort at arriving at a proper conclusion the percentage by weight proportions of the several distillates will have to be determined. As an illustration of one of the phenomena involved, it is only necessary to show the drop in temperature for the respective fractions of automobile gasoline as follows:

RATE OF EVAPORATION AT A CONSTANT TEMPERATURE

Hexane.	Heptane.	Octane.	Decane.
19	17.9	17.2	14.8

From a perusal of these figures the conclusion will be reached that at a given temperature 19 units of hexane will evaporate as quickly as 17.9 units of heptane; octane differs but little from heptane in this regard, but decane has an evaporative value of 14.8 as compared with hexane.

Just what is the trend in automobile fuel is difficult to predict. It is not believed that there is a shortage of raw material (crude oil), but it may be that automobiles will increase in number so rapidly in time that a shortage of fuel will be indicated. Alcohol is, of course, an excellent possibility in this event, but composite fuel is promising also; alcohol may be a content in composite fuel.

An Approximation of the Composition of Gasoline

Name.	Formula.	Density.	Volatility.	Calorific.
Butane	C_4H_{10}	0.600	1	
Pentane, iso.	C_5H_{12}	0.628	31	
Pentane, normal	C_5H_{12}	0.626	36	
Hexane	C_6H_{14}	0.674	68.5	7,155
Hexahydrobenzine	C_6H_{12}	0.760	69	
Hexahydrotoulene	C_7H_{12}	0.772	97	
Heptane	C_7H_{16}	0.688	98	7,380
Octane	C_8H_{18}	0.719	120	7,560
Octane, normal	C_8H_{18}	0.707	125	
Nonane, a	C_9H_{20}	0.740	136	7,900
Nonane, normal	C_9H_{20}	0.722	150	
Decane	$C_{10}H_{22}$	0.738	160	8,060
Benzine	C_6H_6	0.884	80.4	9,690
Toulene	C_7H_8	0.871	111	

Alcohol and the External Combustion Engine

By WILLIAM D. ENNIS, Professor of Mechanical Engineering, Polytechnic Institute of Brooklyn.

Tells about alcohol as a fuel; discusses the Binary vapor principle; comparison is made between alcohol and steam; distinguishes between internal and external combustion engines; discusses the characteristics of the several fluids, as alcohol, gasoline, ether, acetone, chloroform, carbon bisulphide, and steam; mentions some controlling considerations, and ends with drawn conclusions.

ITS general distribution and freedom from noxious qualities have caused water to become the almost universal medium in power engines of the external combustion type. Yet the question often arises whether some other fluid, if procurable at low cost, might not permit of the attainment of higher thermal efficiency. This question is often met by a rather callow assertion of what is sometimes called the second law of thermodynamics, viz., that motive power is obtainable from heat only by virtue of a fall of temperature; that efficiency depends upon this fall, and is not affected by the nature of the working substance. As pointed out by Professor Wood some twenty years ago, however, this is a restricted statement, applicable only to an ideal engine that never has been or can be built; "in practice, the efficiency of all vapor engines depends upon the nature of the working fluid, and involves both the latent heat of evaporation and the specific heat." Furthermore, the maximum pressures to be withstood by an engine of stated efficiency are intimately related to the nature of the fluid which it uses; so that commercially, the proposal to substitute other vapors for steam is not to be dismissed as an absurdity.

Engines have been built in which ammonia—the NH_3 used in refrigerating machines—replaced steam. The apparatus consisted of boiler, engine and condenser, as in any ordinary steam-power plant. But while water boils at 212 degrees Fahrenheit, ammonia boils at —28 degrees Fahrenheit. It is always boiling; to prevent loss it must be confined. A plant of this sort must then, necessarily, run condensing. Again, the use of a condenser, with steam, permits of a reduction of the pressure to that corresponding to a boiling point of about 110 degrees Fahrenheit—say 1.27 pounds absolute—while with ammonia, we can hardly count on cooling water lower than 59 degrees Fahrenheit, at which the vapor pressure is 106 pounds absolute. No ammonia engine, therefore, could produce power unless supplied with vapor at a pressure exceeding 106 pounds. The only comparison possible between ammonia and steam, then, would involve an extremely high initial pressure—say, 200 pounds or more; and such a comparison would be absurd, because there would be no reason for maintaining 106 pounds back pressure on the steam engine.

The Binary Vapor Principle

The amount of back-pressure—pressure resisting the expulsion of the fluid from the cylinder—in any engine depends first on the cooling water temperature, and second, on the pressure-temperature relation for the fluid used. With steam, although cooling water is frequently available at temperatures as low as 60 degrees Fahrenheit, the pressure corresponding to this temperature is so low that it is mechanically impossible to realize it. About the best that can be done is to maintain a vacuum of say 27 or 28 inches of mercury, and the exhaust temperature of the steam is then approximately 110 degrees Fahrenheit. Now a low exhaust temperature is both practically and thermodynamically desirable, irrespective of the pressure temperature relation; hence there are disadvantages in the use of steam as a medium. To overcome these, du Trembley, some sixty years ago, built an engine having two cylinders. The first was supplied with

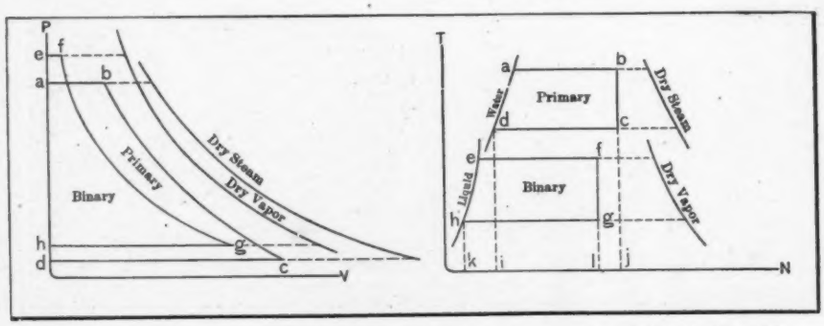


Fig. 1—The Binary vapor principle, with an expose of the points to be made

steam, which after doing its work passed about the coils of what was virtually a closed-feed water heater. Through these coils was circulated *ether*, which was vaporized by the waste heat of the steam and employed as a working fluid in the second cylinder of the engine. The fuel consumption shown by test was 2.44 pounds of coal per horsepower hour. More recently Professor Josse has tested at Charlottenburg an engine using a similar combination of steam and *sulphur dioxide*, which has shown an economy practically the same as that attained in the best recorded steam engine test. Regardless of the dicta of both Rankine and Wood on the subject, and the results of these tests, it is correct to say that the binary vapor principle permits of slightly higher efficiency than can be attained by any engine using steam alone. The relatively low boiling point of the binary fluid permits of a reduced lower temperature limit without leading to impossibilities in condenser design. Ether boils at 96 degrees Fahrenheit, sulphur dioxide at 14 degrees Fahrenheit. The boiling point of the latter is 59 degrees Fahrenheit when under an absolute pressure of 40 pounds per square inch. It can thus be reduced in temperature practically to that of the cooling water without the use of a vacuum pump at all.

External Combustion Engines

The steam engine belongs to that class of engine in which the working substance is externally heated by transmission from the products of combustion of a fuel. In an internal-combustion engine, on the other hand, the products of combustion constitute the working substance, and the fuel is burned in the cylinder. The latter is the principle of the gas or gasoline engine. External combustion engines using gas or oil have, however, been constructed. In one form of launch motor, gasoline is vaporized in a boiler, and this vapor is used as a working fluid, just as steam would be used, in an ordinary steam cylinder, being afterward condensed in order to save it. The fuel used in the boiler is also gasoline, or in some cases, kerosene. An engine in which the fuel was gasoline was tested by Messrs. Doty and Beyer in 1888. The boiler was built up of 3-4 inch copper tubing. The consumption of gasoline per horsepower hour was 3.53 pounds. Its boiling point at atmospheric pressure was about 140 degrees Fahrenheit. The engine ran non-condensing, and the exhaust temperature was not far from 142 degrees Fahrenheit. The lowest temperature that could be attained by a non-condensing steam engine at sea level would be 212 degrees Fahrenheit. The following approximate values were ascertained for the gasoline used:

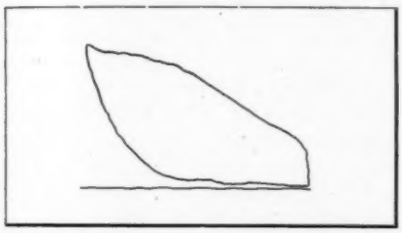


Fig. 3—Indicator card, external combustion engine using gasoline vapor

Pressure, lbs. per sq. in.	Temperature, deg. F.
14.7	140
49.7	225
61.7	242
74.7	258

In a modern type of launch engine, gasoline is used as a fuel to vaporize alcohol, which latter fluid drives an ordinary "steam engine" and is then condensed to be used over again. The object is not superior thermal efficiency at all; but quicker "steaming." The specific heat of liquid alcohol is 0.715; that of water is 1.0. The boiling point of the former is 175 degrees Fahrenheit, that of the latter is 212 degrees Fahrenheit (both at atmospheric pressure). At 142 pounds pressure, alcohol boils at 302 degrees Fahrenheit, water at 354 degrees Fahrenheit. The corresponding latent heats of vaporization are 307 and 867 B.t.u. The units of heat to be supplied in vaporizing one pound of each of these substances from a feed temperature of 100 degrees Fahrenheit are approximately,

for alcohol, 0.715 (302-100) + 307 = 451;
and for water, 1.0 (354-100) + 867 = 1121.

The alcohol boiler will then "get up steam" in $\frac{451}{1121} = \frac{4}{10}$ the time necessary in the case of the steam boiler, even if both are supplied with the same fuel. Against this, we have the incomparable difference in price between water and alcohol. An engine using the latter must run condensing. This means additional first cost and complication. Suppose the working fluid to be gasoline instead of alcohol. Again, for economy, the plant must be condensing, and odor and danger are not eliminated to such an extent as when alcohol is employed. The operation of "getting up steam" is, however, still more rapid.

Alcohol vs. Steam

It seems fair to compare the theoretical efficiencies, using steam and ethyl alcohol, with pressure limits of 150 and 1.27 pounds, both absolute. The following thermal properties are tabular:

	Steam		Alcohol	
Pressure, lbs. per sq. in.....	1.27	150	1.27	150
Heat of the liquid, B. t. u.....	77.94	330.2	27.29	210.15
Latent heat of vaporization...	1030	863.2	432.97	305.04
Temperature, deg. F.....	110	358.5	79	305

In addition to these, we need to know the entropies of the liquids and of vaporization at the two pressure limits. For steam, these also are tabular, being as follows:

At 150 pounds pressure, entropy of liquid = 0.5142, of vaporization = 1.0550;

At 1.27 pounds pressure, entropy of liquid = 0.1471, of vaporization = 1.8082.

For alcohol, the difference of liquid entropy between the two pressure limits is very nearly

$$n = K \log_e \frac{305 + 460}{79 + 460} = 0.368\ K,$$

K being the mean specific heat of the liquid, equal approximately to

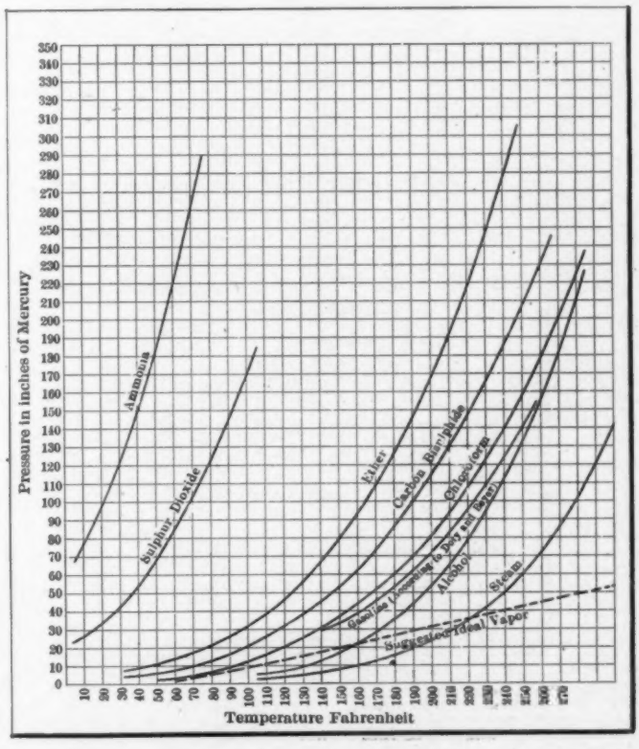


Fig. 2—Temperature-pressure curves of vapors (1 inch of mercury = 0.49 lbs. per sq. in.)

$$\frac{210.15-27.29}{226}=0.808,$$

Whence $n=0.368\times0.808=0.296$. The entropies of vaporization are

$$\frac{305.04}{305+460}=0.400,\text{ at 150 pounds pressure,}$$

and $$\frac{432.97}{79+460}=0.808\text{ at 1.27 pounds pressure.}$$

In an ideal vapor cycle using a vapor intially dry, the dryness at the end of expansion is computed by a familiar formula of thermodynamics,

$$n_2-n_1+N_2=xN_1,$$

in which the symbols n refer to liquid entropies, N to entropies of vaporization, and the subscripts 1 and 2 to the lower and upper pressure limits respectively. We have, then, for alcohol,

$$0.296+0.400=0.808\ x$$

whence $x=0.862$: and for steam

$$0.5142-0.1471+1.0550=1.8082\ x$$

whence $x=0.79$.

The efficiency of this ideal cycle is expressed by the formula,

$$(h_2-h_1+L_2-xL_1)\div(h_2-h_1+L_2),$$

in which the symbols h stand for heats of liquids, and L for latent heat of vaporization; the subscripts having the same significance as before. This leads to

$$\text{Ideal efficiency with steam}=\frac{330.2-77.94+863.2-(0.79\times1030)}{330.2-77.94+863.2}=0.271,$$

and with alcohol =

$$\frac{210.15-27.29+305.04-(0.862\times432.97)}{210.15-27.29+305.04}=0.235$$

The comparison is distinctly unfavorable to alcohol, and the reason is not far to seek. Ideal efficiency is increased as the temperature range is increased. In establishing the same pressure limits for both steam and alcohol, we have necessarily fixed the temperature range at 79 degrees Fahrenheit to 305 degrees Fahrenheit for the latter and 110 degrees Fahrenheit to 358 degrees Fahrenheit for the latter. The steam works through 248.5 degrees Fahrenheit and the alcohol through 226 degrees Fahrenheit.

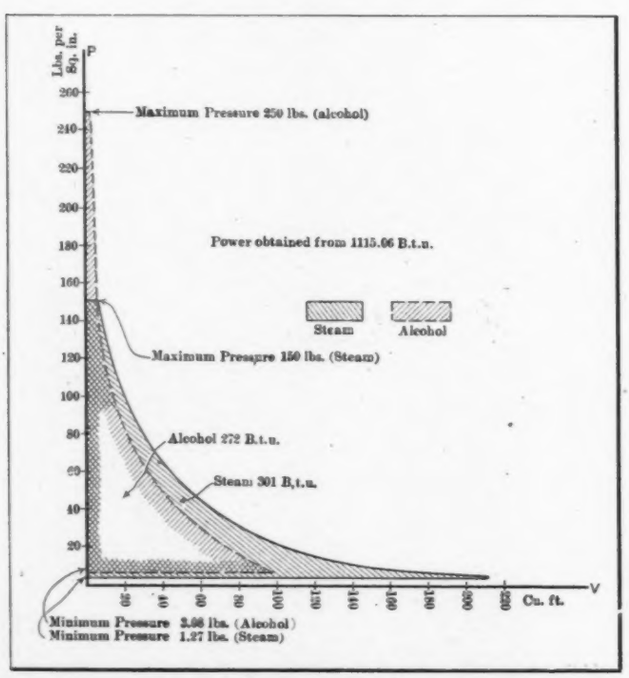


Fig. 4—Power diagram drawn to show the pressure per square inch under different conditions involving alcohol and steam

The Choice of a Fluid

While alcohol, ether, sulphur dioxide or gasoline have the advantage arising from a low boiling point in decreasing the lower temperature limit without making excessive demands upon the vacuum pump, that very fact leads to the disadvantage of a high pressure at the upper limit of temperature: which can be escaped only when the variation of pressure with temperature is much less rapid than is the case with steam. The following table shows how various substances compare in this respect:

	Corresponding pressure at the boiling point, lbs. per sq. in.						
Temp., deg. F.	Ethyl Alcohol	Gasoline	Ether	Acetone	Chloroform	Carbon Bisulphide	Steam
113	3.35	8.20	21.0	10.0	8.79	14.3	1.38
248	62.9	54.6	150.	88.5	76.5	100.3	28.8

All of these substances permit of a lower exhaust temperature than can be obtained with steam, either condensing or non-condensing; but all of them also give at even as moderate a temperature as 248 degrees Fahrenheit, a pressure considerably in excess of that necessary in the steam engine. The question of mechanical design for higher pressures has already become sufficiently troublesome to limit the development of the steam engine in that direction. A slight gain in thermal efficiency at a cost of a serious jump in pressure would not be worth considering. The only substitute for steam seems to be in the direction of the binary vapor engine, in which the binary fluid will never be worked at high pressure.

Removal of Upper Pressure Limit

While the comparison is not fair, and has little practical bearing, it is interesting to note what results follow the adoption of 358.5 degrees Fahrenheit as the upper temperature limit in the case of the alcohol engine just considered. (It is to be noted that the lower temperature limit remains unchanged.) The latent heat of vaporization at 358.5 degrees Fahrenheit is 276; the heat of the liquid is 264; the pressure approaches 250 pounds per square inch. (We have extrapolated values only for the thermal properties at this temperature.) The difference of liquid entropy between 79 degrees and 358.5 degrees is, very nearly,

$$\frac{264-27.29}{358.5-79}\log_e\frac{358.5+460}{79+460}=\frac{236.71}{279.5}=\log_e\frac{818.5}{539}$$

$$=0.849\times2.3\ \log\ 1.52=0.356.$$

The entropy of vaporization at 358.5 degrees Fahrenheit is

$$\frac{276}{358.5+460}=0.338.$$

The dryness at the end of adiabatic expansion comes from

$$0.356+0.338=0.808\ x\text{ as }x=0.694\div0.808=0.86$$

The efficiency of the alcohol vapor cycle between 358.5 degrees Fahrenheit and 79 degrees Fahrenheit is then

$$\frac{264-27.29+276-(0.86\times432.97)}{264-27.29+270}=\frac{512.71-372}{512.71}=0.274,$$

slightly greater than that of the steam cycle with the same upper temperature limit and same lower pressure limit; but the alcohol engine must stand 250 pounds pressure and the steam engine only 150 pounds. Considering the temperature limits as fixing the ideal efficiency, the steam cycle is the better of the two, for it gives practically the same efficiency, although working with a temperature range 31 degrees or 11 per cent. less.

Identical Temperature Limits

Suppose we compare steam and alcohol, both working between 358.5 degrees Fahrenheit and 110 degrees Fahrenheit. The potential efficiency is the same in both cases,

$$\frac{358.5-110}{358.5+460}=0.304$$

For alcohol, at 110 degrees Fahrenheit, the pressure is 3.14

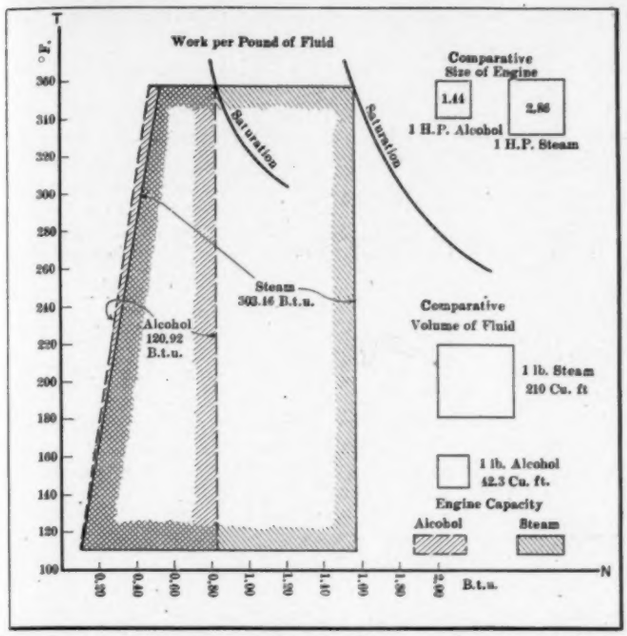


Fig. 5—A construction used in making a comparison between alcohol and steam, giving the relative sizes of engines

pounds, the heat of the liquid is 46.58, and the heat of vaporization is 426.22. The difference in liquid entropy between 110 degrees and 358.5 degrees Fahrenheit is

$$\frac{264-46.58}{358.5-110} = \frac{358.5+460}{110+460}\log_e = \frac{217.42}{248.5}\log e \frac{818.5}{570} =$$

$$0.878 \times 2.3 \log 1.437 = 0.32$$

The dryness at the end of adiabatic expansion is

$$(0.32+0.338) \div \frac{426.22}{110+460} = 0.876,$$

and the efficiency of the alcohol cycle is

$$\frac{264-46.58+276-(0.876\times 426.22)}{264-46.58+276} = 0.245,$$

against 0.271, as already found for the steam cycle.

Additional Considerations

In the comparison last made, the work obtained from one pound of fluid is given by the numerator of the efficiency expression: For alcohol, it is 120.92 B.t.u., and for steam, 303.46 B.t.u. The engine cylinder must be sufficiently large to hold one pound of fluid at the lowest pressure attained in the cycle in order that these amounts of power may be exerted by the one pound in each case. The volumes are obtained (approximately) by multiplying the volume of one pound of dry vapor at the lowest pressure by its dryness after adiabatic expansion. This gives, for steam, $265.5 \times 0.79 = 210$, and for alcohol, $48.238 \times 0.876 = 42.3$; the first figures of each product being tabular specific volumes. The ratio of

$$\frac{\text{work per pound of fluid}}{\text{volume of cylinder per pound of fluid}}$$

is then, for steam, 1.44, and for alcohol 2.86. An engine of given size, operated with alcohol, will then develop about twice the amount of power that will be developed when steam is used as a fluid. An extension of this calculation will show that the higher pressure necessary in a practical alcohol engine might be partially offset, so far as its influence on first cost is concerned, by the smaller size of cylinder necessary.

Again, the amount of heat to be abstracted by condensing water is given by the last term of the numerators of the efficiency expressions. For steam, this is $0.79 \times 1030 = 813$; for alcohol, it is $0.876 \times 426.22 = 375$. The ratios of these quantities to power developed are,

for steam, $813 \div 303.46 = 2.69$;
and for alcohol, $375 \div 120.92 = 3.10$.

The alcohol will require more cooling water per horsepower in the ratio of 3.10 to 2.69; say 15 per cent. more; and the necessary size of condenser will be correspondingly increased.

Conclusions

Some of the results of these computations are shown graphicacally in Figs. 4, 5 and 6. In the first, we have the ideal indicator diagrams obtained from alcohol and steam working betweeen 358.5 degrees Fahrenheit and 110 degrees Fahrenheit. The maximum pressures are shown as 250 and 150 lbs., and the minimum as 3.08 and 1.27 lbs., respectively. Our computations gave a work area of 301 B.t.u. with steam when the total heat supplied was 1115.06 B.t.u. Reducing the work obtained from alcohol to the same basis of heat supplied, we obtain 272 B.t.u. The two shaded areas of Fig. 4 then represent the relative efficiencies of the two fluids with identical temperature limits.

Fig. 5 shows the entropy diagrams for the two ideal cycles. Here the work areas obtained *per pound* of fluid are given as 120.92 and 303.46 B.t.u. The difference in specific volumes at the lower temperature limit (indicated by the two squares in the lower righthand corner of the diagram) leads, however, to a greater output from a given cylinder when supplied with alcohol than when supplied with steam; or, as represented by the squares in the upper righthand corner of the diagram, the steam engine of a given horsepower is twice as large as the alcohol engine.

Fig. 6, again, shows the heat to be removed by the cooling water per pound of fluid; b j e a for alcohol, b i h a for steam. The lesser amount of work obtained from a pound of alcohol, however, offsets this and leads to the result shown; the condenser for alcohol must be 15 per cent. larger, and the amount of cooling water supplied must be 15 per cent greater, than with steam.

Thermal efficiency is limited (a) by the mechanical difficulties accompanying high initial pressures or temperatures, and (b) by the difficulty of attaining a low temperature limit, on account of the normally available 60 degrees or 70 degrees Fahrenheit temperature of cooling water and the mechanical difficulties in maintaining a vacuum even at this temperature. Steam is as satisfactory a vapor as any, if we consider condition (a). It is almost the least satisfactory of any under condition (b), but the gain in eliminating high vacua at the lower limit is so small that the thermal properties of any specific vapor may be such as to offset it. The cooling water temperature imposes an insurmountable barrier to progress in respect to this lower limit. With a properly chosen fluid the binary vapor principle may lead to the highest thermal efficiencies, but these are not likely to be commercially profitable on any wide scale. Specimen comparisons show alcohol to be rather less efficient than steam as a working fluid: we have insufficient data to consider gasoline. The reason for using these substances arises from convenience, quick steaming, etc., and the alcohol engine may be smaller than a steam engine of same power.

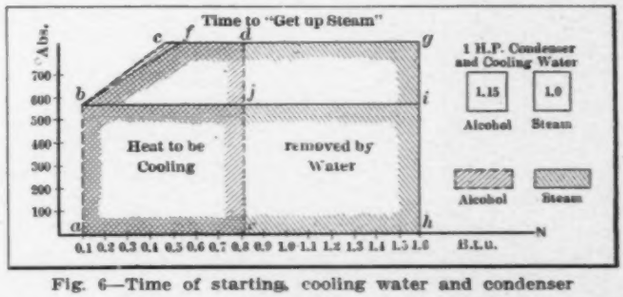


Fig. 6—Time of starting, cooling water and condenser

(The comparative times required to "get up steam" are indicated by the areas a b c d e—alcohol,—and a b f g h—steam. This is for equal weights of fluid in the boilers. These areas have the ratio 4:10. The amounts of heat to be removed by the condenser cooling water per pound of fluid are represented by the areas b j e a—alcohol,—and b i h a—steam; the ration being 4.6:10. Since more work is obtained per pound of fluid in the case of steam—see Fig. 5—the cooling water supply and size of condenser per horsepower are, however, reduced below those necessary for alcohol.)

Standardized Formulæ for Ready Reference

By THOS. J. FAY

Dealing with simplified conversion formulæ set for the slide rule, or to be used independent of same, logically arranged, and indexed by number—Empirical formulæ for determining horsepower approximations (a) for steam engines, and (b) for internal combustion motors—Practical electrical formulæ derived from the fundamental system for use in ignition work—Practical electromagnetic formulæ derived from the fundamental system for use in designing ignition systems—Abbreviated adaptations of general engineering formulæ for quick approximations

AUTOMOBILE ENGINEERS have to deal with many old problems in new garb, and the fixed formula which obtains for bridge building, electrical engineering, and battleship designing, while it holds the crux of the situation from these points of view, lacks in fineness in view of the more delicate task which confronts the designer of the automobile. Empirical formulæ in particular are dangerous to apply to the newer art, using the constants which were found to serve under the well-defined conditions which were established for the older arts. Even with a derived formula having for its basis the fundamental system, there is a certain amount of danger involved, and before it can be claimed that the automobile is standardized, it will be necessary to standardize the formula which is to serve as the method of precision for the designer.

In the shop when a part is fashioned it goes to the inspection department, where a deft inspector, imbued with high ideas, utilizes micrometers, extensometers, and fixed gauges to enable him to fix the standard the workman observes. To arrive at such close conclusions in the shop, it goes without saying that they should be based upon a mathematical design which will serve as an exact foundation for results so obtained. If the designer uses a formula which leads to wrong conclusions, what an enormous waste of talent and money it is to use $5,000 worth of instruments of precision in the process of proving how nearly the artisan comes to making the thing wrong! If the mathematical hypothesis is wrong, then the part involved, if it is made according to the formula, will be wrong, and every effort to arrive at accuracy of workmanship, under such conditions, will be for no better purpose than to show that the workman furnished a Chinese copy of a wrong design.

The method of comparison, which undoubtedly obtains to a wide extent, when reference is had to automobile designing, cannot represent the last word because no one can be held responsible for the accuracy of the parts which are used in the copying process. Even if an axle does hold up in some one make of automobile, and even if it is extensively copied, these facts do not constitute proper groundwork for a standardized product. If the original and possibly well-designed axle falls short of the perfection which would be indicated by proper investigation and the utilization of sound mathematical formulæ tempered by practical considerations, every effort based upon it will be below the standard which a board of capable engineers would be proud to embrace as their own.

The time must come in the automobile industry when the methods which are relied upon in the engineering office will be universal in character and bear the stamp of approval of a board of competent engineers empowered to act. In every other art, heterogeny of designing method was ultimately set aside in favor of crystallized endeavor due to systematic investigation, as, for illustration, the master car builders' specifications (M. C. B.) are the rule and guide in every effort involving the building of cars, the tracks on which they roll, and the locomotives that draw them. Likewise, in shipbuilding the Lloyds construction is recognized by insurance underwriters as the standard to measure by, just as in medicine the United States Pharmacopœia states the dosage which the sick must endure.

Fixed Formulæ Dealing with Geometrical Problems

$$\text{Circumference} = \frac{710 \times \text{Diameter}}{226} \quad \ldots\ldots(1)$$

$$\text{Diameter} = \frac{226 \times \text{circumference}}{710} \quad \ldots\ldots(2)$$

$$\text{Diameter} = \frac{99 \times \text{side inscribed square}}{70} \quad \ldots\ldots(3)$$

$$\text{Side inscribed square} = \frac{70 \times \text{Diameter}}{99} \quad \ldots\ldots(4)$$

$$\text{Diameter} = \frac{70 \times \text{side of equal square}}{79} \quad \ldots\ldots(5)$$

$$\text{Side of equal square} = \frac{79 \times \text{Diameter}}{70} \quad \ldots\ldots(6)$$

$$\text{Circumference} = \frac{39 \times \text{side of equal square}}{11} \quad (7)$$

$$\text{Side of equal square} = \frac{11 \times \text{circumference}}{39} \quad (8)$$

$$\text{Diagonal of square} = \frac{99 \times \text{side of square}}{70} \quad (9)$$

$$\text{Side of square} = \frac{70 \times \text{diagonal of square}}{99} \quad (10)$$

$$\text{Area of circle} = \frac{322 \times \text{Area of inscribed square}}{205} \quad \ldots\ldots(11)$$

Fixed Formulæ Dealing with Arithmetical Conversions

$$\text{Feet} = \frac{66 \times \text{Links}}{100} \quad \ldots\ldots(12)$$

$$\text{Links} = \frac{100 \times \text{Feet}}{66} \quad \ldots\ldots(13)$$

$$\text{Square Feet} = \frac{44 \times \text{Square Links}}{101} \quad \ldots\ldots(14)$$

$$\text{Square Links} = \frac{101 \times \text{Square Feet}}{44} \quad \ldots\ldots(15)$$

$$\text{Cubic Inches} = \frac{231 \times \text{U. S. Gallons}}{1} \quad \ldots\ldots(16)$$

$$\text{U. S. Gallons} = \frac{\text{Cubic Inches}}{231} \quad \ldots\ldots(17)$$

$$\text{Cubic Inches} = \frac{6{,}100 \times \text{Imperial Gallons}}{22} \quad \ldots\ldots(18)$$

$$\text{Imperial Gallons} = \frac{22 \times \text{Cubic Inches}}{6{,}100} \quad \ldots\ldots(19)$$

$$\text{Inches} = \frac{95 \times \text{Links}}{12} \quad \ldots\ldots(20)$$

$$\text{Links} = \frac{12 \times \text{Inches}}{95} \quad \ldots\ldots(21)$$

$$\text{Imperial Gallons} = \frac{5 \times \text{U. S. Gallons}}{6} \quad \ldots\ldots(22)$$

$$\text{U. S. Gallons} = \frac{6 \times \text{Imperial Gallons}}{5} \quad \ldots\ldots(23)$$

$$\text{Cubic Feet} = \frac{107 \times \text{U. S. Gallons}}{800} \quad \ldots\ldots(24)$$

$$\text{U. S. Gallons} = \frac{800 \times \text{Cubic Feet}}{107} \quad \ldots\ldots(25)$$

$$\text{Cubic Feet} = \frac{69 \times \text{Imperial Gallons}}{430} \quad \ldots\ldots(26)$$

$$\text{Imperial Gallons} = \frac{430 \times \text{Cubic Feet}}{69} \quad \ldots\ldots(27)$$

Conversions in Metric and English Units

$$\text{Meters} = \frac{25 \times \text{Feet}}{82} \quad \ldots\ldots(28)$$

$$\text{Feet} = \frac{82 \times \text{Meters}}{25} \quad \ldots\ldots(29)$$

$$\text{Miles} = \frac{87 \times \text{Kilometers}}{140} \quad \ldots\ldots(30)$$

$$\text{Kilometers} = \frac{140 \times \text{Miles}}{87} \quad \ldots\ldots(31)$$

$$\text{Meters} = \frac{26 \times \text{Centimeters}}{66} \quad \ldots\ldots(32)$$

$$\text{Cent'meters} = \frac{66 \times \text{Meters}}{26} \quad \ldots\ldots(33)$$

$$\text{Meters} = \frac{75 \times \text{Yards}}{82} \quad \ldots\ldots(34)$$

$$\text{Yards} = \frac{82 \times \text{Meters}}{75} \quad \ldots\ldots(35)$$

$$\text{Meters} = \frac{865 \times \text{Links}}{4{,}300} \quad \ldots\ldots(36)$$

$$\text{Links} = \frac{4{,}300 \times \text{Meters}}{865} \quad \ldots\ldots(37)$$

$$\text{Square Centimeters} = \frac{200 \times \text{Sq. Inches}}{31} \quad \ldots\ldots(38)$$

$$\text{Sq. Inches} = \frac{31 \times \text{Sq. Centimeters}}{200} \quad \ldots\ldots(39)$$

$$\text{Sq. Meters} = \frac{51 \times \text{Sq. Yards}}{61} \quad \ldots\ldots(40)$$

$$\text{Sq. Yards} = \frac{61 \times \text{Sq. Meters}}{51} \quad \ldots\ldots(41)$$

$$\text{Sq. Miles} = \frac{22 \times \text{Sq. Kilometers}}{57} \quad \ldots\ldots(42)$$

$$\text{Sq. Kilometers} = \frac{57 \times \text{Sq. Miles}}{22} \quad \ldots\ldots(43)$$

$$\text{Cubic Feet} = \frac{17 \times \text{Cubic Meters}}{600} \quad \ldots\ldots(44)$$

$$\text{Cubic Meters} = \frac{600 \times \text{Cubic Feet}}{17} \quad \ldots\ldots(45)$$

$$\text{Cubic Feet} = \frac{6 \times \text{Litres}}{170} \quad \ldots\ldots(46)$$

$$\text{Litres} = \frac{170 \text{ Cubic Feet}}{6} \quad \ldots\ldots(47)$$

$$\text{Litres} = \frac{209 \times \text{Imperial Gallons}}{46} \quad \ldots\ldots(48)$$

$$\text{Imperial Gallons} = \frac{46 \times \text{Litres}}{209} \quad \ldots\ldots(49)$$

$$\text{Grams} = \frac{170 \times \text{Ounces}}{6} \quad \ldots\ldots(50)$$

$$\text{Ounces} = \frac{6 \times \text{Grams}}{170} \quad \ldots\ldots(51)$$

$$\text{Kilograms} = \frac{3{,}200 \times \text{Hundredweight}}{63} \quad \ldots\ldots(52)$$

$$\text{Hundredweight} = \frac{63 \times \text{Kilograms}}{3{,}200} \quad \ldots\ldots(53)$$

$$\text{Meters} = \frac{865 \times \text{Chains}}{43} \quad \ldots\ldots(54)$$

$$\text{Chains} = \frac{43 \times \text{Meters}}{865} \quad \ldots\ldots(55)$$

$$\text{Sq. Meters} = \frac{13 \times \text{Sq. Ft.}}{140} \quad \ldots\ldots(56)$$

$$\text{Sq. Feet} = \frac{140 \times \text{Sq. Meters}}{13} \quad \ldots\ldots(57)$$

$$\text{Acres} = \frac{42 \times \text{Hectares}}{17} \quad \ldots\ldots(58)$$

$$\text{Hectares} = \frac{17 \times \text{Acres}}{42} \quad \ldots\ldots(59)$$

$$\text{Cubic Inches} = \frac{5 \times \text{Cubic Centimeters}}{82} \quad \ldots\ldots(60)$$

$$\text{Cubic Centimeters} = \frac{82 \times \text{Cubic Inches}}{5} \quad \ldots\ldots(61)$$

$$\text{Cubic Yards} = \frac{85 \times \text{Cubic Meters}}{65} \quad \ldots\ldots 62)$$

$$\text{Cubic Meters} = \frac{65 \times \text{Cubic Yards}}{85} \quad \ldots\ldots(63)$$

$$\text{U. S. Gallons} = \frac{14 \times \text{Litres}}{53} \quad \ldots\ldots(64)$$

$$\text{Litres} = \frac{53 \times \text{U. S. Gallons}}{14} \quad \ldots\ldots(65)$$

$$\text{Grains} = \frac{108 \times \text{Grams}}{7} \quad \ldots\ldots(66)$$

$$\text{Grams} = \frac{7 \times \text{Grains}}{108} \quad \ldots\ldots(67)$$

$$\text{Pounds} = \frac{75 \times \text{Kilograms}}{34} \quad \ldots\ldots(68)$$

$$\text{Kilograms} = \frac{34 \times \text{Pounds}}{75} \quad \ldots\ldots(69)$$

$$\text{English Ton} = \frac{63 \times \text{Metric Ton}}{64} \quad \ldots\ldots(70)$$

$$\text{Metric Ton} = \frac{64 \times \text{English Ton}}{63} \quad \ldots\ldots(71)$$

Conversion Formulæ Involving Pressures

$$\text{Pounds per Sq. Inch} = \frac{640 \times \text{Kilograms per Sq. Centimeter}}{45} \quad \ldots\ldots(72)$$

$$\text{Kilograms per Sq. Centimeter} = \frac{45 \times \text{Pounds per Sq. Inch}}{640} \quad \ldots\ldots(73)$$

$$\text{Pounds per Sq. Yard} = \frac{59 \times \text{Kilograms per Sq. Meter}}{32} \quad \ldots\ldots(74)$$

$$\text{Kilograms per Sq. Meter} = \frac{32 \times \text{Pounds per Sq. Yard}}{59} \quad \ldots\ldots(75)$$

$$\text{Inches of Mercury} = \frac{82 \times \text{Pounds per Sq. Foot}}{5{,}800} \quad \ldots\ldots(76)$$

$$\text{Pounds per Sq. Foot} = \frac{5{,}800 \times \text{Inches of Mercury}}{82} \quad \ldots\ldots(77)$$

$$\text{Inches of Water} = \frac{74 \times \text{Pounds per Sq. Foot}}{385} \quad \ldots\ldots(78)$$

$$\text{Pounds per Sq. Foot} = \frac{385 \times \text{Inches of Water}}{74} \quad \ldots\ldots(79)$$

$$\text{Feet of Water} = \frac{5 \times \text{Pounds per Sq. Foot}}{312} \quad \ldots\ldots(80)$$

$$\text{Pounds per Sq. Foot} = \frac{312 \times \text{Feet of Water}}{5} \quad \ldots\ldots(81)$$

$$\text{Atmospheres} = \frac{99 \times \text{Inches of Mercury}}{2{,}960} \quad \ldots\ldots(82)$$

$$\text{Inches of Mercury} = \frac{2{,}960 \times \text{Atmospheres}}{99} \quad \ldots\ldots(83)$$

$$\text{Atmospheres} = \frac{34 \times \text{Pounds per Sq. Foot}}{7{,}200} \quad \ldots\ldots(84)$$

$$\text{Pounds per Sq. Foot} = \frac{7{,}200 \times \text{Atmospheres}}{34} \quad \ldots\ldots(85)$$

$$\text{Atmospheres} = \frac{23 \times \text{Feet of Water}}{780} \quad \ldots\ldots(86)$$

$$\text{Feet of Water} = \frac{780 \times \text{Atmospheres}}{23} \quad \ldots\ldots(87)$$

$$\text{Pounds per Sq. Inch} = \frac{29 \times \text{Feet of Water}}{67} \quad \ldots\ldots(88)$$

$$\text{Feet of Water} = \frac{67 \times \text{Pounds per Sq. Inch}}{29} \quad \ldots\ldots(89)$$

$$\text{Pounds per Sq. Foot} = \frac{51 \times \text{Kilograms per Sq. Meter}}{249} \quad \ldots\ldots(90)$$

$$\text{Kilograms per Sq. Meter} = \frac{249 \times \text{Pounds per Sq. Foot}}{51} \quad \ldots\ldots(91)$$

$$\text{Inches of Mercury} = \frac{57 \times \text{Pounds per Sq. Inch}}{28} \quad \ldots\ldots(92)$$

$$\text{Pounds per Sq. Inch} = \frac{28 \times \text{Inches of Mercury}}{57} \quad \ldots\ldots(93)$$

$$\text{Inches of Water} = \frac{720 \times \text{Pounds per Sq. Inch}}{26} \quad \ldots\ldots(94)$$

$$\text{Pounds per Sq. Inch} = \frac{26 \times \text{Inches of Water}}{720} \quad \ldots\ldots(95)$$

$$\text{Feet of Water} = \frac{60 \times \text{Pounds per Sq. Inch}}{26} \quad \ldots\ldots(96)$$

$$\text{Pounds per Sq. Inch} = \frac{26 \times \text{Feet of Water}}{60} \quad \ldots\ldots(97)$$

$$\text{Inches of Mercury} = \frac{15 \times \text{Feet of Water}}{17} \quad \ldots\ldots(98)$$

$$\text{Feet of water} = \frac{17 \times \text{Inches of Mercury}}{15} \quad \ldots\ldots(99)$$

$$\text{Atmospheres} = \frac{34 \times \text{Pounds per Sq. Inch}}{500} \quad \ldots\ldots(100)$$

$$\text{Pounds per Sq. Inch} = \frac{500 \times \text{Atmospheres}}{34} \quad \ldots\ldots(101)$$

$$\text{Atmospheres} = \frac{30 \times \text{Kilograms per Sq. Centimeter}}{31} \quad \ldots\ldots(102)$$

$$\text{Kilograms per Sq. Centimeter} = \frac{31 \times \text{Atmospheres}}{30} \quad \ldots\ldots(103)$$

$$\text{Atmospheres} = \frac{3 \times \text{Meters of Water}}{31} \quad \ldots\ldots(104)$$

$$\text{Meters of Water} = \frac{31 \times \text{Atmospheres}}{3} \quad \ldots\ldots(105)$$

43 × Kilograms per Meter

Combinations Using Metric and English Units

$$\text{Pounds per Foot} = \frac{43 \times \text{Kilograms per Meter}}{64} \quad \ldots\ldots(106)$$

$$\text{Kilograms per Meter} = \frac{64 \times \text{Pounds per Foot}}{43} \quad \ldots\ldots(107)$$

$$\text{Pounds per Sq. Yard} = \frac{46 \times \text{Kilograms per Sq. Meter}}{25} \quad \ldots\ldots(108)$$

$$\text{Kilograms per Sq. Meter} = \frac{25 \times \text{Pounds per Sq. Yard}}{46} \quad \ldots\ldots(109)$$

$$\text{Pounds per Cubic Yard} = \frac{27 \times \text{Kilograms per Cubic Meter}}{16} \quad \ldots\ldots(110)$$

$$\text{Kilograms per Cubic Meter} = \frac{16 \times \text{Pounds per Cubic Yards}}{27} \quad \ldots(111)$$

$$\text{Imperial Gallons per Minute} = \frac{700 \times \text{Litres per Second}}{53} \quad \ldots(112)$$

$$\text{Litres per Second} = \frac{53 \times \text{Imperial Gallons per Minute}}{700} \quad \ldots(113)$$

$$\text{Pounds per Yard} = \frac{127 \times \text{Kilograms per Meter}}{63} \quad \ldots(114)$$

$$\text{Kilograms per Meter} = \frac{63 \times \text{Pounds per Yard}}{127} \quad \ldots(115)$$

$$\text{Pounds per Cubic Foot} = \frac{49 \times \text{Kilograms per Cubic Meter}}{785} \quad \ldots(116)$$

$$\text{Kilograms per Cubic Meter} = \frac{785 \times \text{Pounds per Cubic Foot}}{49} \quad \ldots(117)$$

$$\text{Cubic Feet per Minute} = \frac{89 \times \text{Litres per Second}}{42} \quad \ldots(118)$$

$$\text{Litres per Second} = \frac{42 \times \text{Cubic Feet per Minute}}{89} \quad \ldots(119)$$

$$\text{U. S. Gallons per Minute} = \frac{840 \text{ Litres per Second}}{53} \quad \ldots(120)$$

$$\text{Litres per Second} = \frac{53 \times \text{U. S. Gallons per Minute}}{840} \quad \ldots(121)$$

Practical Electrical Formulæ Fundamentally Derived

$$R = \frac{E}{I} = \text{Resistance in Ohms} \quad \ldots(122)$$

$$R = \frac{W}{I^2} = \text{Resistance in Ohms} \quad \ldots(123)$$

$$R = \frac{E^2}{W} = \text{Resistance in Ohms} \quad \ldots(124)$$

$$I = \frac{E}{R} = \text{Current in Amperes} \quad \ldots(125)$$

$$I = \frac{W}{E} = \text{Current in Amperes} \quad \ldots(126)$$

$$I = \sqrt{\frac{W}{R}} = \text{Current in Amperes} \quad \ldots(127)$$

$$E = IR = \text{Electromotive Force in Volts} \quad \ldots(128)$$

$$E = \frac{W}{I} = \text{Electromotive Force in Volts} \quad \ldots(129)$$

$$E = \sqrt{WR} = \text{Electromotive Force in Volts} \quad \ldots(130)$$

$$W = EI = \text{Energy in Watts} \quad \ldots(131)$$

$$W = I^2R = \text{Energy in Watts} \quad \ldots(132)$$

$$W = \frac{E^2}{R} = \text{Energy in Watts} \quad \ldots(133)$$

$$J = \frac{E^2}{R}t = \text{Heat in Joules} \quad \ldots(134)$$

$$J = I^2Rt = \text{Heat in Joules} \quad \ldots(135)$$

$$J = EIt = \text{Heat in Joules} \quad \ldots(136)$$

$$Q = \frac{E}{R}t = \text{Quantity in Columbs} \quad \ldots(137)$$

$$Q = It = \text{Quantity in Coulombs} \quad \ldots(138)$$

$$C = \frac{Q}{E} = \text{Capacity in Farads} \quad \ldots(139)$$

$$C = \frac{(It)}{E} = \text{Capacity in Farads} \quad \ldots(140)$$

$$C = \frac{\left\{\frac{E}{R}t\right\}}{E} = \text{Capacity in Farads} \quad \ldots(141)$$

Note:—In the construction of condensers for use in magnetos and spark coils in connection with ignition systems for automobile motors, a more practical determination of condenser capacity is expressed as follows:

Let,
- C = Capacity in farads;
- Cl = Capacity in micro-farads;
- k = A constant representing the specific inductive capacity of the dielectric;
- A = Area of conductor plates in square centimeters;
- d = Distance between plates (thickness of dielectric) in millimeters;

When,

$$C = \frac{kA}{4\pi d} = \text{Capacity in Farads} \quad \ldots(142)$$

$$Cl = \frac{k\,A}{1.1313 \times d \times 10^7} = \text{Capacity in Micro-Farads} \quad \ldots(143)$$

$$A = \frac{1.1313 \times k \times d \times 10^7}{k} = \text{Area in Sq. Centimeters} \quad \ldots(144)$$

Note:—The specific inductive capacity of air equals unity; the specific inductive capacity of other media is variable, but authorities give some of the values as follows:

Paraffine	= 2.16
Oiled paper	= 2.00
Mica	= 4.75
Ebonite	= 2.67
Petroleum	= 2.05
Ozokerite	= 2.10

Relation of Horsepower to Electromagnetic Units

Since 1 watt equals 1-746 of a horsepower, the relations as follows hold:

$$\text{H.P.} = \frac{W}{746} = \text{Horsepower} \quad \ldots(145)$$

$$\text{H.P.} = \frac{EI}{746} = \text{Horsepower} \quad \ldots(146)$$

$$\text{H.P.} = \frac{I^2R}{746} = \text{Horsepower} \quad \ldots(147)$$

$$\text{H.P.} = \frac{\left\{\frac{E^2}{R}\right\}}{746} = \text{Horsepower} \quad \ldots(148)$$

$$\text{H.P.} = \frac{KW \times 1{,}000}{746} = \text{Horsepower} \quad \ldots(149)$$

$$\text{K.W.} = \frac{\text{H.P.} \times 746}{1{,}000} = \text{Kilowatts} \quad \ldots(150)$$

Heat Equivalent of Electrical Energy

$$H = I^2Rt \times 0.24 = \text{Calories} \quad \ldots(151)$$

$$t = \frac{H}{I^2R} \times 0.24 = \text{Time in Seconds} \quad \ldots(152)$$

Conventional Formulæ of the Steam Engine

$$\text{I.H.P.} = \frac{Ps \times A \times Mp}{33{,}000} = \text{Indicated horsepower} \quad \ldots(153)$$

$$Mp = \frac{\text{I.H.P.} \times 33{,}000}{A \times Ps} = \text{Mean effective pressure} \quad \ldots(154)$$

$$A = \frac{\text{I.H.P.} \times 33{,}000}{Mp \times Ps} = \text{Area in Square Inches} \quad \ldots155$$

$$Ps = \frac{\text{I.H.P.} \times 33{,}000}{A \times Mp} = \text{Piston Travel in Feet Per Minute.} \quad \ldots(156)$$

The mean effective pressure to be expected from a properly constructed and suitably adjusted steam engine may be approximated as follows:

$$Mp\ (1\text{-}4\ \text{cut-off}) = \frac{Ip \times 34}{57} = \text{Mean effective pressure} \quad \ldots(157)$$

$$Mp\ (3\text{-}8\ \text{cut-off}) = \frac{Ip \times 23}{31} = \text{Mean effective pressure} \quad \ldots(158)$$

$$Mp\ (1\text{-}2\ \text{cut-off}) = \frac{Ip \times 11}{13} = \text{Mean effective pressure} \quad \ldots(159)$$

$$Mp\ (5\text{-}8\ \text{cut-off}) = \frac{Ip \times 34}{37} = \text{Mean effective pressure} \quad \ldots(160)$$

$$Mp\ (3\text{-}4\ \text{cut-off}) = \frac{Ip \times 53}{55} = \text{Mean effective pressure} \quad \ldots(161)$$

$$Mp\ (7\text{-}8\ \text{cut-off}) = \frac{Ip \times 124}{125} = \text{Mean effective pressure} \quad \ldots(162)$$

For a single-acting steam engine working 1-4 cut-off, if it is in good working order and the valves are tight, the horsepower to be realized should be as follows:

$$\text{I.H.P.} = \frac{\left(d^2\frac{\pi}{4}\right) \times \left(\frac{Ip \times 34}{57}\right) \times \left(\frac{S \times 2}{12} \times R\right)}{33{,}000} = \text{indicated hp.} \quad \ldots(163)$$

When,
- Ip = Initial steam pressure:
- S = Stroke in inches:
- R = Crankshaft speed in revolutions per minute:
- d^2 = Square of diameter of piston in inches.

Simple Rating Formulæ for Automobile Motors

The Association of Licensed Automobile Manufacturers, in an attempt to "rate" motors, reached the conclusion that there is no formulæ that will give absolutely accurate results, and, in the absence of a formulæ that can be relied upon to do more, preferred to lay down one that all may use on a nominal basis, taking for a foundation the conventional motors of the day, and a piston travel of 1,000 feet per minute as permissible. This formulæ is stated as follows:

$$\text{H.P.} = \frac{d^2n}{2.5} = \text{horsepower} \quad \ldots(164)$$

When,
- d^2 = square of diameter of cylinder in inches;
- n = number of cylinders on a 4-cycle basis.

It is believed that the time has arrived in the automobile motor when users would prefer to introduce a little complication if only they may be able to see for themselves the effect of a stroke. This may be accomplished in the manner as follows:

$$\text{H.P.} = \left\{\frac{m^2 \times m^1 \times n \times s}{10^9}\right\}k = \text{horsepower} \quad \ldots(165)$$

When,
- m^2 = square of bore in millimeters;
- m^1 = stroke in millimeters;
- n = number of 4-cycle cylinders;
- s = speed of crankshaft in revolutions per minute;
- k = a constant for a given type and design of motor;
- k = 4 for the conventional type of automobile motor;
- 10^9 = 1,000,000,000.

Note.—In dividing by 10^9 it is only necessary to point off to 9 decimal places. This formula, like that of the A.L.A.M., is purely empirical, hence is limited in its application to present types of 4-cycle motors. It closely approximates the power as realized from reasonably well-designed motors.

Relations of Torque, Speed and Power

It is frequently desirable to determine the relations of torque, speed and power; they may be ascertained as follows:

$$H.P. = \frac{2\pi RSP}{33{,}000} = \text{horsepower} \quad \ldots\ldots(166)$$

$$R = \frac{H.P. \times 33{,}000}{2\pi SP} = \text{radius of the lever-arm} \quad \ldots\ldots(167)$$

$$S = \frac{H.P. \times 33{,}000}{2\pi RP} = \text{speed in revolutions per minute} \quad \ldots\ldots(168)$$

$$P = \frac{H.P. \times 33{,}000}{2\pi RS} = \text{pull in pounds at end of lever-arm} \quad \ldots\ldots(169)$$

With a Prony brake, using the above equation, if the length of the lever-arm is 5.4 feet, the horsepower becomes:

$$H.P. = \frac{6.28 \times SP}{1{,}000} = \text{horsepower} \quad \ldots\ldots(170)$$

Loads on Ball Bearings in Gear Transmissions*

ASIDE from the advantages of small friction, as compared with cylindrical bearings, and relative independence of lubrication, ball bearings offer undisputed points of superiority for automobiles in their ability to absorb end thrusts. A certain percentage of the radial load may be transformed into end thrust without harm. If a shaft has been designed too weak and bends under overload or shock, so that the inner race goes askew, the lateral stresses are without much trouble taken up by the balls, while with parallel bearings heating and scoring of shaft or bearing, with their evil consequences, are always to be feared.

But the stability of the shaft needs to be well looked after if two ball bearings close to one another are depended upon for the support of the load, as otherwise a bending of the shaft causes one of the bearings to be overloaded. The admissible loads for single ball bearings are given in the tables covering this subject and should not be exceeded. The loads on the gear pinion shafts in a transmission mechanism change greatly, however, according to the gear speed, and reach their maximum at low speed and reverse. At the other speeds the load on the ball bearing is considerably reduced. If, therefore, the dimensions of the ball bearing are decided according to the stresses obtaining at low speed or on the reverse, there will be a large unutilized surplus strength for the other gear ratios. Investigation of the transmissions used in a number of well-known automobiles shows, on the other hand, that the ball bearings in many cases are considerably overloaded. But temporary overloading of the materials is nothing new in automobile construction, and is also well endured within reasonable limits, owing to the excellence of the special automobile steels. Considering that the low speed and the reverse are switched into use only off and on and then only for a brief period, a small overload for the bearings at these speeds should be admissible with a view to a better utilization of ball bearings in normal operation, but in many instances in practice the overload is too great.

Roller bearings have been placed on the market which agree in dimensions with the established ball bearings and may be substituted for them, while capable of supporting loads 100 to 150 per cent. higher.

In the following there is offered an examination of ball bearing loads at the different gear speeds in a number of automobiles, with disregard of friction losses. The tables will show the actual loads and also the loads which are given as admissible by the manufacturers of ball bearings for the corresponding number of revolutions in each instance. The formula employed for the calculation of the turning moment is:

$$N = 0.4 \times 1 \times d^2 \times s \times 1200$$

but at the present advanced stage of motor design the coefficient 0.4 should be raised to 0.5 or 0.6, which will give 25 to 50 per cent. higher loads for given dimensions than are indicated in the tables, and an examination of the latter will disclose that, when this additional load due to the increased power of motors (as compared with their power at the time when the formula was calculated) is also considered, several transmissions show an overload even for the second speed. At the close of each table the percentage of overload, if any, is given. The data are compiled from published specifications.

An example of the calculations, with application of the above-mentioned formula, is given in full in the case of the Lorraine-Dietrich 20-horsepower transmission, used with a motor of 90 mm cylinder bore and 120 mm stroke.

The number of teeth on the various pinions is as follows:

Pinion A—26 teeth } giving a constant transmission ratio of 1 to 1.42
Pinion B—37 teeth }
Pinion C—15 teeth
Pinion D—41 teeth
Pinion E—23 teeth
Pinion F—33 teeth
Pinion G—29 teeth
Pinion H—27 teeth
Pinion J—17 teeth } reverse
Pinion K—12 teeth }

Multiplying with the constant gear speed ratio of 1 to 1.42, the total ratios for each gear speed are found to be 1 to 3.86 for low speed, 1 to 2.04 for second speed, 1 to 1.32 for third speed, 1 to 1 for fourth speed and 1 to 5.5 for the reverse.

The turning moment for shaft I is now seen to be 11 kilogrammeters and for shaft II 15.6 kilogrammeters. For shaft III the low speed gives a turning moment of 42.5 kilogrammeters; the second speed 22.4 kilogrammeters; the third 14.5 kilogrammeters; the fourth 11 kilogrammeters, and the reverse 60 kilogrammeters.

The stress on the teeth of the pinions A and B becomes 11,000 divided by 52, which equals 212 kilograms; for C and D, 15,600 divided by 33.75, which is 462 kilograms; for E and F, 15,600 divided by 51.75, or 302 kilograms; for G and H, 15,600 divided by 65.25, or 240 kilograms, and for the pinion-pair, K and J, the pressure rises to 7624 divided by 12, or 652 kilograms.

Looking at the diagram of the transmission, it will be noticed that the distances from the points where the shafts sustain their loads to the ball bearings are given in millimeters. Figuring with these distances in each case, the stresses upon the bearings are found to be as follows:

a_1 = stress on bearing a at low speed =

$$\frac{212 \times 35}{68} - \frac{126 \times 12}{68} = 109 - 22 = 87 \text{ kg.}$$

a_2 = stress on bearing a at second speed =

$$\frac{212 \times 35}{68} - \frac{178 \times 12}{68} = 109 - 31 = 78 \text{ kg.}$$

a_3 = stress on bearing a at third speed =

$$\frac{212 \times 35}{68} - \frac{167 \times 12}{68} = 109 - 29 = 80 \text{ kg.}$$

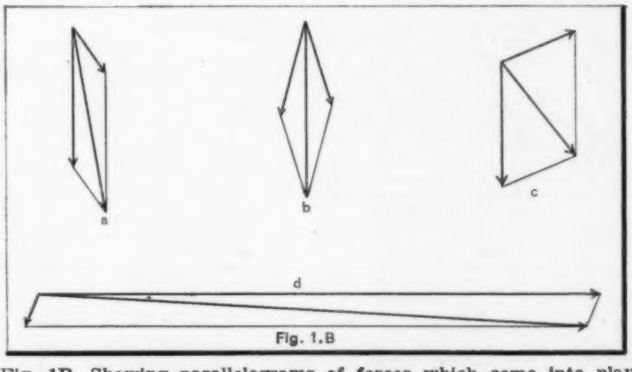


Fig. 1B—Showing parallelograms of forces which come into play when reverse is applied at various speeds

* Translation of article in *Der Motorwagen* by J. Dornacher.

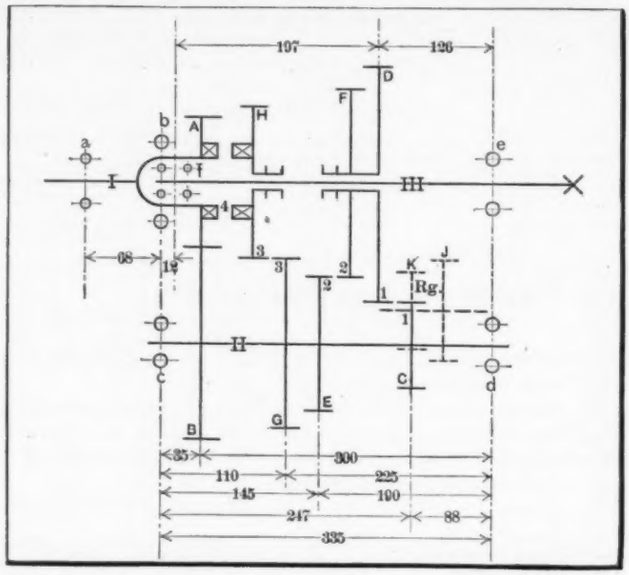


Fig. 1A—Diagram of transmission of the Lorraine-Dietrich

b_1 = stress on bearing b at low speed = $\frac{212 \times 103}{68} - \frac{126 \times 80}{68} = 321 - 148 = 173$ kg.

b_2 = stress on bearing b at second speed = $\frac{212 \times 103}{68} - \frac{178 \times 80}{68} = 321 - 209 = 112$ kg.

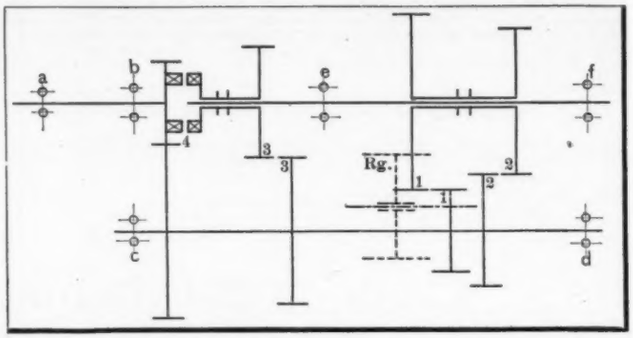


Fig. 2—Diagram of the transmission of the Protos "18-35"

b_3 = stress on bearing b at third speed = $\frac{212 \times 103}{68} - \frac{167 \times 80}{68} = 321 - 196 = 125$ kg.

c_1 = stress on bearing c at low speed = $\frac{212 \times 300}{335} - \frac{462 \times 88}{335} = 190 - 122 = 68$ kg.

c_2 = stress on bearing c at second speed = $\frac{212 \times 300}{335} - \frac{302 \times 190}{335} = 190 - 171 = 19$ kg.

c_3 = stress on bearing c at third speed = $\frac{212 \times 300}{335} - \frac{240 \times 225}{335} = 190 - 161 = 29$ kg.

d_1 = stress on bearing d at low speed = $\frac{462 \times 247}{335} - \frac{212 \times 35}{335} = 340 - 22 = 318$ kg.

d_2 = stress on bearing d at second speed = $\frac{302 \times 145}{335} - \frac{212 \times 35}{335} = 131 - 22 = 109$ kg.

LORRAINE-DIETRICH
90 mm Bore; 120 mm Stroke
Fig. 1A

	Ball Bearing		a	b	c	d	e	f
Load in kg. at:		Reverse	150	595	183	332	398	254
		Low speed	87	173	68	318	336	126
		2d speed	78	112	19	109	124	178
		3d speed	80	125	29	57	73	167
Ball-bearing number			210	213	307	407	310	205 double
Admissible load in kilograms according to r.p.m. in each case, as authorized by:	Deutsche Waffen- und Munitionsfabrik	Reverse	315	540	410	720	1100	220
		Low speed	315	540	410	720	1035	270
		2d speed	315	540	410	720	840	300
		3d speed	315	540	410	720	750	350
	Maschinenfabrik "Rheinland"	Reverse	335	520	400	620	940	190
		Low speed	335	520	400	620	870	250
		2d speed	335	520	400	620	725	290
		3d speed	335	520	400	620	605	330
	Fichtel u. Sachs .1 W. H. cage	Reverse	320	600	435	870	1390	190
		Low speed	320	600	435	870	1330	330
		2d speed	320	600	435	870	1135	400
		3d speed	320	600	435	870	915	480
	Fichtel u. Sachs .2 Solid cage	Reverse	250	450	385	680	1090	140
		Low speed	250	450	385	680	1030	240
		2d speed	250	450	385	680	835	300
		3d speed	250	450	385	680	650	380
	Kugelfabrik Fischer A.-G.	Reverse	165	310	305	575	1160	130
		Low speed	165	310	305	575	1040	180
		2d speed	165	310	305	575	775	270
		3d speed	165	310	305	575	525	390
Overload in Percentage:	Deutsche Waffen- und Munitionsfabrik	Reverse	.....	10	.....	.....	.....	51
		Low speed	.....	.....	.....	.....	.....	.....
		2d-speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....
	Maschinenfabrik "Rheinland"	Reverse	.....	14	.....	.....	.....	33
		Low speed	.....	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....
	Fichtel u. Sachs .1	Reverse	.....	.....	.....	.....	.....	33
		Low speed	.....	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....
	Fichtel u. Sachs .2	Reverse	.....	32	.....	.....	.....	81
		Low speed	.....	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....
	Kugelfabrik Fischer A.-G.	Reverse	.....	92	.....	.....	.....	95
		Low speed	.....	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....

PROTOS, 18-35 H.P.
110 mm Bore; 120 mm Stroke
Fig. 2

	Ball-Bearing		a	b	c	d	e	f
Load in kg. at:		Reverse	170	645	130	675	720	300
		Low speed	170	645	130	675	546	474
		2d speed	170	645	265	540	308	442
		3d speed	170	645	65	160	646	76
Ball-bearing number			307	408	306	406	408	309
Admissible load in kilograms according to r.p.m. in each case, as authorized by:	Deutsche Waffen- und Munitionsfabrik	Reverse	360	740	355	680	1140	870
		Low speed	360	740	355	680	1140	870
		2d speed	360	740	355	680	1025	780
		3d speed	360	740	355	680	840	670
	Maschinenfabrik "Rheinland"	Reverse	325	615	330	560	1040	840
		Low speed	325	615	330	560	1040	840
		2d speed	325	615	330	560	930	750
		3d speed	325	615	330	560	760	625
	Fichtel u. Sachs .1 W. H. cage	Reverse	350	750	480	870	1460	1160
		Low speed	350	750	480	870	1460	1160
		2d speed	350	750	480	870	1350	1050
		3d speed	350	750	480	870	1060	840
	Fichtel u. Sachs .2 Solid cage	Reverse	300	650	340	680	1260	900
		Low speed	300	650	340	680	1260	900
		2d speed	300	650	340	680	1150	760
		3d speed	300	650	340	680	940	620
	Kugelfabrik Fischer A.-G.	Reverse	220	.....	330	550	1150	920
		Low speed	220	.....	330	550	1150	920
		2d speed	220	.....	330	550	950	765
		3d speed	220	.....	330	550	.....	550
Overload in Percentage:	Deutsche Waffen- und Munitionsfabrik	Reverse	.....	.....	.....	.....	.....	.....
		Low speed	.....	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....
	Maschinen- W fabrik "Rheinland"	Reverse	.....	5	.....	20	.....	.....
		Low speed	.....	5	.....	20	.....	.....
		2d speed	.....	5	.....	.....	.....	.....
		3d speed	.....	5	.....	.....	.....	.....
	Fichtel u. Sachs .1	Reverse	.....	.....	.....	.....	.....	.....
		Low speed	.....	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....
	Fichtel u. Sachs .2	Reverse	.....	.....	.....	.....	.....	.....
		Low speed	.....	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....
	Kugelfabrik Fischer A.-G.	Reverse	.....	.....	.....	22	.....	.....
		Low speed	.....	.....	.....	22	.....	.....
		2d speed	.....	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....	.....

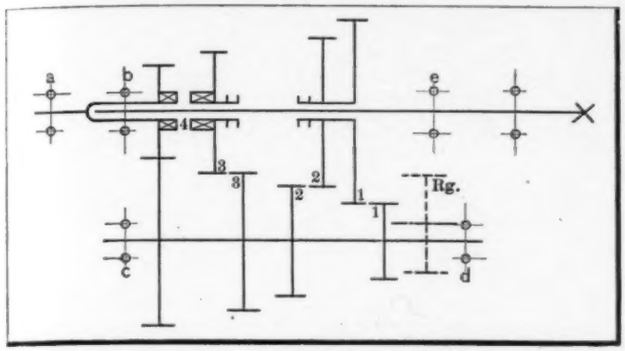


Fig. 3—Diagram of the transmission of the N. A. G. "35"

d_3 = stress on bearing d at third speed = $\frac{240 \times 110}{335} - \frac{212 \times 35}{335} = 79 - 22 = 57$ kg.

e_1 = stress on bearing e at low speed = $\frac{462 \times 235}{323} = 336$ kg.

e_2 = stress on bearing e at second speed = $\frac{302 \times 133}{323} = 124$ kg.

e_3 = stress on bearing e at third speed = $\frac{240 \times 98}{323} = 73$ kg.

f_1 = stress on bearing f at low speed = $\frac{462 \times 88}{323} = 126$ kg.

f_2 = stress on bearing f at second speed = $\frac{302 \times 109}{323} = 178$ kg.

f_3 = stress on bearing f at third speed = $\frac{240 \times 225}{323} = 167$ kg.

The parallelograms of the forces which come into play when the reverse is applied at the various speeds are indicated in the diagram Fig. 1B, in which the figures are marked a, b, c and d, the letters corresponding to those denoting the bearing under stress in each case.

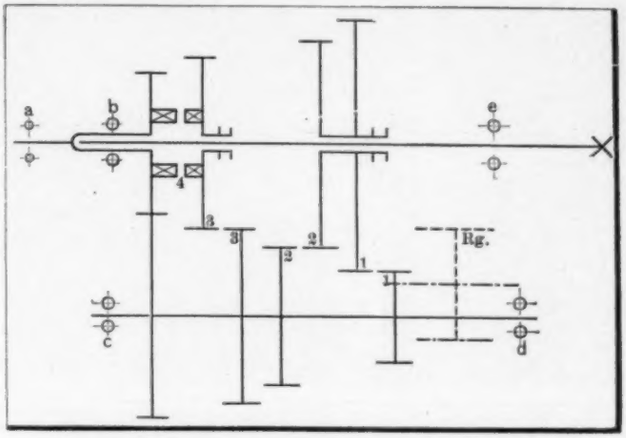


Fig. 4—Diagram of the transmission of the Peugeot "70"

Working these resultants out graphically, the compounded stresses on bearings a, b, c and d are found to be as follows when the reverse is applied:

a_r = stress on bearing a at reverse, composed of $\frac{212 \times 35}{68} = 109$ kg.

and $\frac{254 \times 12}{68} = 45$ kg.; resultant = 150 kg.

N. A. G., 35 H. P.
115 mm Bore; 125 mm Stroke
Fig. 3

	Ball Bearing		a	b	c	d	e
Load in kg. at		Reverse	230	950	460	800	780
		Low speed	230	618	168	760	892
		2d speed	230	378	62	295	384
		3d speed	230	354	58	150	216
Ball bearing number			308	308	307	307	309
Admissible load in kilograms according to r.p.m. in each case, as authorized by:	Deutsche Waffen- und Munitionsfabrik	Reverse	460	460	450	450	825
		Low speed	460	460	450	450	825
		2d speed	460	460	450	450	740
		3d speed	460	460	450	450	660
	Maschinenfabrik "Rheinland"	Reverse	400	400	445	445	835
		Low speed	400	400	445	445	835
		2d speed	400	400	445	445	715
		3d speed	400	400	445	445	620
	Fichtel u. Sachs .1 W. H. cage	Reverse	450	450	495	495	1155
		Low speed	450	450	495	495	1155
		2d speed	450	450	495	495	1000
		3d speed	450	450	495	495	820
	Fichtel u. Sachs .2 Solid cage	Reverse	350	350	425	425	895
		Low speed	350	350	425	425	895
		2d speed	350	350	425	425	700
		3d speed	350	350	425	425	610
	Kugelfabrik Fischer A.-G.	Reverse	280	280	375	375	895
		Low speed	280	280	375	375	895
		2d speed	280	280	375	375	700
		3d speed	280	280	375	375	550
Overload in Percentage:	Deutsche Waffen- und Munitionsfabrik	Reverse	.....	106	2	78	.....
		Low speed	.....	34	.....	69	8
		2d speed	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....
	Maschinenfabrik "Rheinland"	Reverse	.....	138	3	80	.....
		Low speed	.....	54	.....	71	6
		2d speed	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....
	Fichtel u. Sachs .1 W. H. cage	Reverse	.....	111	.....	61	.....
		Low speed	.....	37	.....	53	.....
		2d speed	.....	.....	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....
	Solid cage Fichtel u. Sachs .2	Reverse	.....	172	8	88	.....
		Low speed	.....	76	.....	78	.....
		2d speed	.....	8	.....	.....	.....
		3d speed	.....	.....	.....	.....	.....
	Kugelfabrik Fischer A.-G.	Reverse	.....	240	22	113	.....
		Low speed	.....	120	.....	102	.....
		2d speed	.....	35	.....	.....	.....
		3d speed	.....	26	.....	.....	.....

PEUGEOT, 70 H.P. (6 CYL.)
130 mm Bore; 140 mm Stroke
Fig. 4

	Ball Bearing		a	b	c	d	e
Load in kg. at:		Reverse	308	1540	725	1104	1018
		Low speed	308	600	154	1038	1178
		2d speed	308	428	28	372	466
		3d speed	308	464	74	200	284
Ball-bearing number			208	209	206	405	212
Admissible load in kilograms according to r.p.m. in each case, as authorized by:	Deutsche Waffen- und Munitionsfabrik	Reverse	270	295	195	430	740
		Low speed	270	295	195	430	740
		2d speed	270	295	195	430	675
		3d speed	270	295	195	430	590
	Maschinenfabrik "Rheinland"	Reverse	275	320	200	410	670
		Low speed	275	320	200	410	670
		2d speed	275	320	200	410	575
		3d speed	275	320	200	410	495
	Fichtel u. Sachs .1 W. H. cage	Reverse	250	280	225	530	935
		Low speed	250	280	225	530	935
		2d speed	250	280	225	530	785
		3d speed	250	280	225	530	675
	Fichtel u. Sachs .2 Solid cage	Reverse	200	230	175	440	665
		Low speed	200	230	175	440	665
		2d speed	200	230	175	440	585
		3d speed	200	230	175	440	485
	Kugelfabrik Fischer A.-G.	Reverse	145	155	150	.....	630
		Low speed	145	155	150	.....	630
		2d speed	145	155	150	.....	480
		3d speed	145	155	150	.....	340
Overload in Percentage:	Deutsche Waffen- und Munitionsfabrik	Reverse	14	422	270	156	37
		Low speed	14	103	.....	142	59
		2d speed	14	45	.....	.....	.....
		3d speed	14	57	.....	.....	.....
	Maschinenfabrik "Rheinland"	Reverse	12	380	262	169	52
		Low speed	12	87	.....	153	75
		2d speed	12	33	.....	.....	.....
		3d speed	12	45	.....	.....	.....
	Fichtel u. Sachs .1	Reverse	23	450	222	108	9
		Low speed	23	114	.....	96	26
		2d speed	23	53	.....	.....	.....
		3d speed	23	65	.....	.....	.....
	Fichtel u. Sachs .2	Reverse	54	570	314	150	53
		Low speed	54	160	.....	136	77
		2d speed	54	86	.....	.....	.....
		3d speed	54	100	.....	.....	.....
	Kugelfabrik Fischer A.-G.	Reverse	112	895	383	.....	62
		Low speed	112	286	.....	.....	87
		2d speed	112	176	.....	.....	.....
		3d speed	112	200	.....	.....	.....

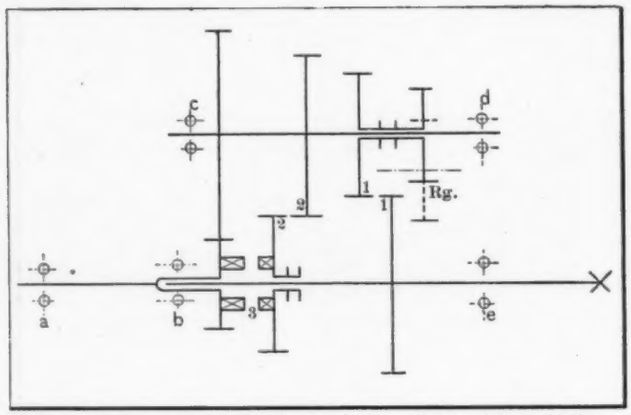


Fig. 5—Diagram of the transmission of the Adler "8-15"

b_r = stress on bearing b at reverse, composed of $\frac{212 \times 103}{68} = 321$ kg.

and $\frac{254 \times 80}{68} = 299$ kg.; resultant = 595 kg.

c_r = stress on bearing c at reverse, composed of $\frac{212 \times 300}{335} = 190$ kg.

and $\frac{462 \times 88}{335} = 122$ kg.; resultant = 183 kg.

d_r = stress on bearing d at reverse, composed of $\frac{212 \times 35}{335} = 22$ kg.

and $\frac{462 \times 247}{335} = 340$ kg.; resultant = 332 kg.

while the stresses on bearings e and f, being simple, are:

$$e_r = \frac{652 \times 197}{323} = 398 \text{ kg.}$$

$$f_r = \frac{652 \times 126}{323} = 254 \text{ kg.}$$

The tables give the results of identical calculations applied to different designs of the transmission mechanism.

ADLER, 8-15 H.P.

80 mm Bore; 100 mm Stroke

Fig. 5

	Ball Bearing		a	b	c	d	e
Load in Kg. at:		Reverse	91	497	235	365	365
		Low speed	40	136	75	254	267
		2d speed	32	78	28	94	110
Ball-bearing number			211	212	205	306	309
Admissible load in kilograms according to r.p.m. in each case, as authorized by:	Deutsche Waffen- und Munitionsfabrik	Reverse	400	520	160	365	830
		Low speed	400	520	160	365	790
		2d speed	400	520	160	365	700
	Maschinenfabrik "Rheinland"	Reverse	365	410	150	340	845
		Low speed	365	410	150	340	790
		2d speed	365	410	150	340	670
	Fichtel u. Sachs .1 W. H. cage	Reverse	380	500	210	500	1165
		Low speed	380	500	210	500	1100
		2d speed	380	500	210	500	920
	Fichtel u. Sachs .2 Solid cage	Reverse	280	400	160	350	910
		Low speed	280	400	160	350	825
		2d speed	280	400	160	350	660
	Kugelfabrik Fischer A.-G.	Reverse	225	250	150	350	910
		Low speed	225	250	150	350	830
		2d speed	225	250	150	350	580
Overload in Percentage:	Deutsche Waffen- und Munitionsfabrik	Reverse	.....	.....	47	.....	.....
		Low speed	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....
	Maschinenfabrik "Rheinland"	Reverse	.....	21	56	7	.....
		Low speed	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....
	Fichtel u. Sachs .1	Reverse	.....	.....	12	.....	.....
		Low speed	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....
	Fichtel u. Sachs .2	Reverse	.....	24	47	4	.....
		Low speed	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....
	Kugelfabrik Fischer A.-G.	Reverse	.....	100	56	4	.....
		Low speed	.....	.....	.....	.....	.....
		2d speed	.....	.....	.....	.....	.....

New Farcot Two-Cylinder Two-Cycle Revolving Motor

PARIS, July 14—There is a considerable amount of originality in the design and construction of the Farcot two-cylinder two-cycle revolving motor now undergoing tests at the laboratory of the Automobile Club of France. As in the case of a very successful French seven-cylinder motor, the designer causes cylinders and crankcase to revolve round a fixed crankshaft. By adopting the two-cycle principle, however, he has got away from the complication of valves and valve mechanism, has reduced weight, and simplified the motor by the abolition of all gear wheels except the magneto driving and driven pinions.

The two cylinders are machined out of a solid bar of nickel steel, together with their radiating fins. Bore is 4.7 inches and stroke 3.9 inches. There is no separate crankcase, the base of each of the two cylinders forming this chamber. The two halves are dovetailed together and secured by an encircling collar, which gives extreme lightness, together with a perfectly gas-tight chamber. The cylinders are offset in relation one to the other in order to allow the use of a two-throw crankshaft of the ordinary type. There is nothing unusual, either, in the design of the connecting rods. Aluminum as the material for pistons is an innovation which, after a series of experiments, has been found satisfactory by the inventor. The pistons are a die casting, ribbed in the head for

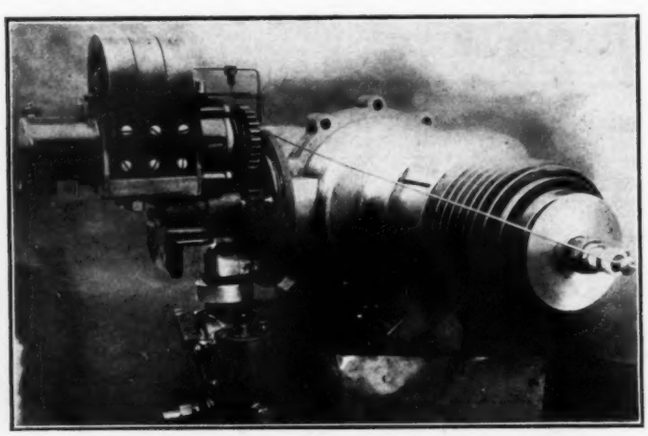


Fig. 1—Farcot 2-cylinder motor of the revolving type, showing the magneto and details of the timing equipment

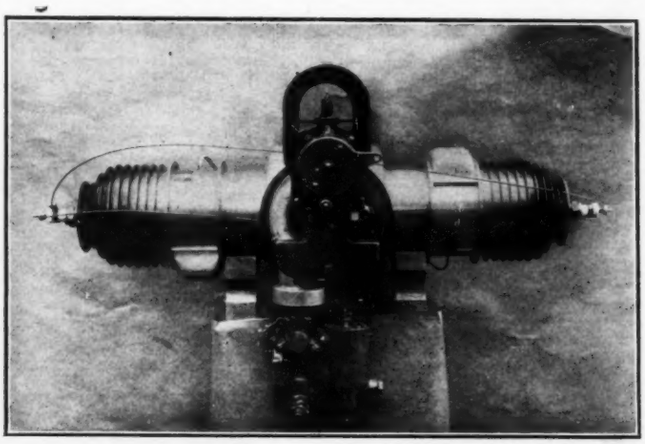


Fig. 2—Farcot 2-cylinder 2-cycle motor, side view, showing location of the carbureter and other details

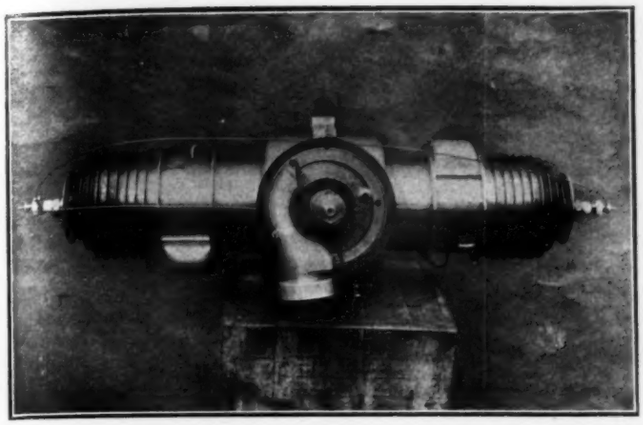


Fig. 3—Opposite side view of Farcot motor showing the exhausting device and methods of construction

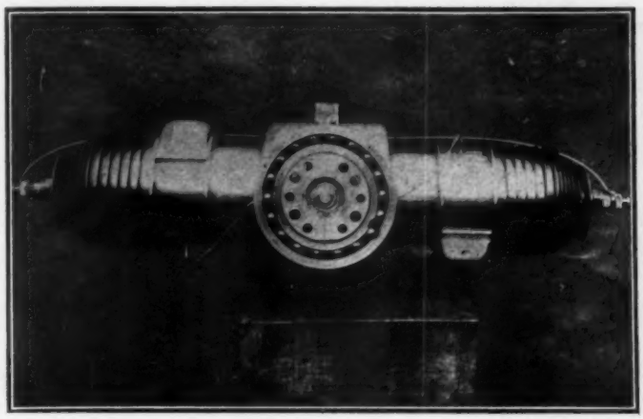


Fig. 4—View of the motor with the magneto removed showing the ball-bearing crankshaft and simplicity in designing

strength, provided with two rings side by side, and carrying the usual type of baffle plate in order to deflect the gases away from the exhaust port.

A standard type of carbureter is employed, with connection to the motor by a single straight length of intake piping. On the end of the crankshaft is a fixed disc with an oval port corresponding with the end of the intake pipe, and in friction with it a revolving disc, also provided with an oval port, revolving with the crankcase. On the upstroke of the pistons the revolving disc uncovers the port on the fixed disc, allowing a mixture to be aspired into the crank chamber. After compression the charge is passed through a series of ports in the walls of the piston, corresponding with similar ports in the walls of the cylinder, into an aluminum chamber applied to the outside of the cylinder and communicating, according to the position of the piston, with both the crank chamber and the combustion chamber. The baffle plate on the piston head deflects the gas towards the upper portion of the cylinder, away from the exhaust port.

Ignition is provided for by a high-tension magneto mounted on a bracket above one extremity of the fixed crankshaft, and driven by a gear wheel on the crankcase. The magneto driving and driven pinions are the only gear wheels in the motor. The spark plugs are in the head of the cylinders. Lubrication is under pressure from a belt-driven lubricator through the hollow crankshaft to the main bearings and the connecting rod ends, with a separate lead, by external pipe, to the cylinder walls.

In complete running order the motor weighs 70 pounds and develops 30 horsepower at 1200 revolutions. A motor on the same principles, but with four instead of two cylinders, has also been constructed with a total weight of 110 pounds for 45 to 50 horsepower at 1100 revolutions. The illustrations give an excellent idea of the appearance of the motor.

Some Light-Weight Motors from Europe

STRAINING many points which experience in the automobile field has well-nigh established as essential for reliability of the internal-combustion motor, designers of engines intended for aviation purposes have gone at the task of creating new relations between power and weight with an ardor which no other purpose than that of gaining prominence and laurels in the new spectacular form of locomotion could have produced. The long-stroke motor, suddenly looked upon with so much favor, may be the upshot of other considerations, such as the keen desire for fuel economy, which is much more pronounced in Europe than here, owing to the higher prices for gasoline, but it is safe to say that air cooling, the two-cycle system and the revolving-cylinder systems would never have gained their new and enthusiastic votaries but for the prevalence of greatly exaggerated notions of the desirability of minimum weight in the power plant of aeroplanes. Though the rage for lightness has already given birth to highly interesting and promising developments, sane reaction against this tendency has already made itself felt. It is becoming understood that not one tittle or iota of reliability should be sacrificed in order to enable the aspiring but perhaps indiscreet aviator to leave the ground easily with a machine of indifferent merit, and that the good aviation motor should be one which might be turned to account for automobile or other earthly purpose without compromising in the least with any other requirements than perhaps that of low cost of production. Even as compared with the motors which in the past have been produced especially for racing automobiles at a cost which at first forbade a wide commercial application, and in which lightness was also a desideratum, the aviation motor is the more exacting, with regard to reliability, since it is necessary that it shall be wholly automatic in its lubricating and cooling systems. On the other hand, the demands born of long-distance racing for a motor capable of being worked at its very highest power development for a very long time without giving trouble, are not at present emphasized to the same degree for aviation motors, it being particularly desirable that the motor which drives the aeroplane shall possess a considerable reserve over and above the power normally employed for flight. All told, the aviation motor, rationally conceived, seems to promise a more direct application to automobile purposes than the quondam racing

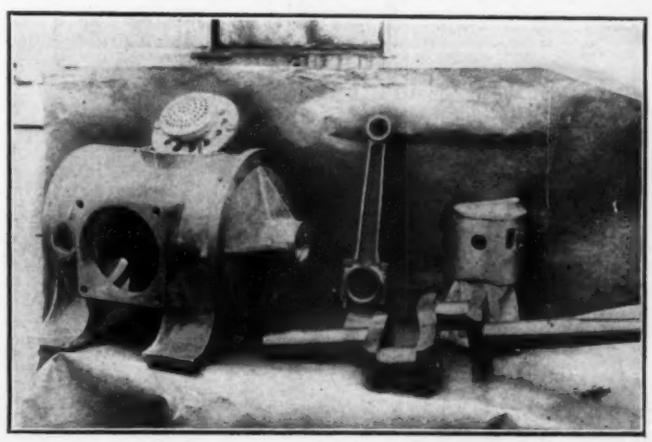


Fig. 5—Component parts of Farcot motor showing the crankshaft, connecting rod and other parts

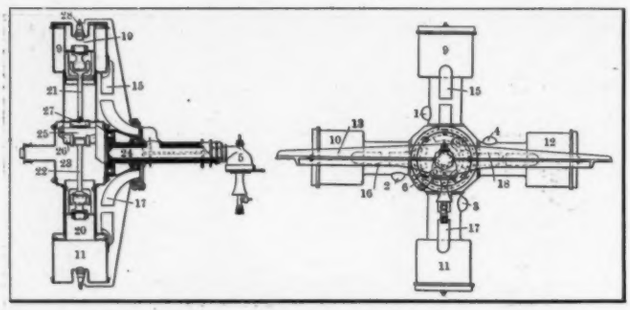


Fig. 2—Sectional views of the Palous & Beuse revolving cylinder two-cycle motor

motor did, and, as it was almost invariably found that all the important advantages in any new racing motor, whatever was its initial price of production, could be duplicated at nothing more than ordinary cost after those advantages had been ratified by experience and factory methods had been applied, it may be assumed that the efforts devoted to the development of the long-stroke, two-cycle, air-cooled, light-weight and high-powered power plant for the road of air will eventually exert a stronger influence in the whole motor field than the automobile racing motors ever did.

There seem to be only two avenues of escape from this conclusion, one in assuming that none of the aviation motors will reach perfection except by returning to the present automobile type; the other, which is even less reasonable, in advancing the assertion that there is something intrinsically inconsistent with low cost of production in the development of those designs which have latterly seen the light of day and of which extreme lightness is at present the most attractive and least disputed feature.

At the present moment the aviation movement has at least broken that trend of conservatism which threatened to throw into oblivion all scientific pursuit of motor perfection in favor of a widespread imitation of certain successful types, and a large number of able designers have been put to work in the world's experimental department, where progress is manufactured from the raw material of fresh ideas, as well as from old ideas once prematurely discarded, but which are showing new values under new conditions, especially the highly improved shop facilities for giving adequate material expression to the designer's conceptions. It would for example have been next to impossible ten years ago to have found any combination of foundry, machine shop, workmen and designer by which the fourteen-cylinder revolving Gnome could have been turned out at commercial cost and in fit condition to run.

Some obvious short cuts to aviation results—which are identical with the capturing of fat prizes at the many meets—still mar the renewed efforts, here and there. The entire genus of motors with revolving cylinders is looked upon by many in that light, on account of the remote chance of having it applied to other uses, but it is especially the separate exhaust from each cylinder through the cylinder heads, a truly pyrotechnical display, which proclaims a serious difficulty in their design, since it is evident that even for aviation the time is not very distant when the exhaust will require to be taken care of in a civilized manner. Fuel waste and lack of flexibility in the power output constitute another marring defect, forgiven at present only because lightness is the concomitant feature which is overvalued.

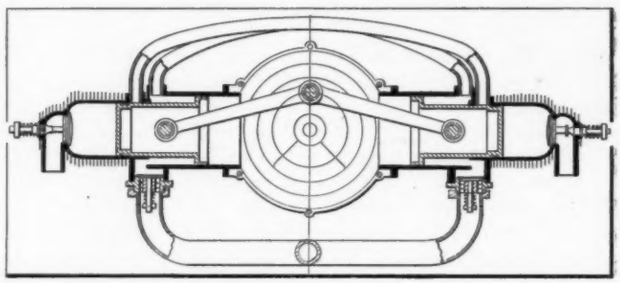


Fig. 6—Sectional view of the Anzani two-cycle motor.

The conservative British Green motor exemplifies prettily what may be done in light construction without departing far from automobile practice. It weighs little more than 4 to 5 pounds per brake horsepower, and its constructive peculiarities may be observed directly on the accompanying drawing, copied from *Der Motorwagen*. Most notable are the following: Dead spaces around the valves are wholly avoided, giving high compression with satisfactory precautions against premature ignition and overheating. Valve parts are interchangeable and easily dismounted. Valves are actuated from the camshaft extending over the tops of the cylinders and enclosed in an aluminum housing, whereby reciprocating masses are reduced as well as dimensions and vibrations. The aluminum housing may be readily unhinged. The water jacket embraces the whole upper portion of the cylinders, including the walls adjacent to the valves. It is tightened at the bottom joint by means of a rubber ring, so as to permit expansion without leak. The combination of parallel and ball bearings for the crankshaft and flywheel should secure uniformity of wear which in turn should afford a good guarantee against the early development of knocking and other irregularities which sooner or later develop into something worse.

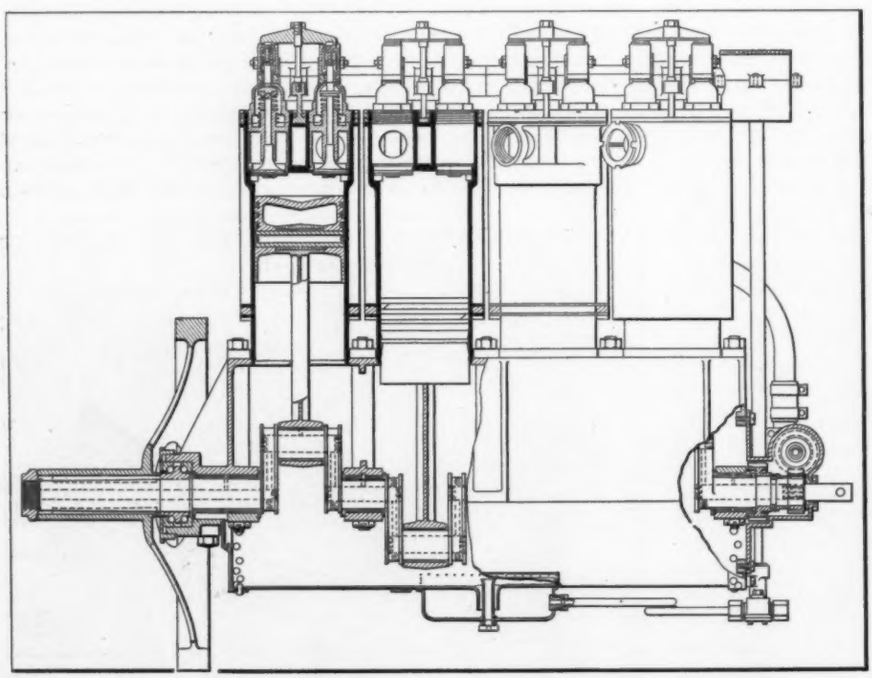


Fig. 1—Construction drawing of the Green motor

Much crankshaft weight is saved by the multiple V-type, of which the Miller motor, built in Italy, is an example. The cylinders are 50° apart, and are fired in the order 1, 3, 2, 4, making the angular distances between explosions 100°, 310°, 100° and 210°, which makes the regularity a little better than for the ordinary four-cylinder V-type motor with two pairs of cylinders 90° apart. One of the con-

necting rods is knuckled so as to embrace the crankpin in the usual manner, and is provided with a rock shaft upon which the three other connecting rods work, this being a simple method for overcoming a mooted difficulty in the multiple V-type and one which apparently works out to satisfaction. With regard to the intake valve there is a return in this motor to the automatic type, which has the advantage of lightness and is, perhaps, as good as one mechanically operated when no extremely low throttling is required. The details of this automatic intake valve are shown in illustration. *A* is an aluminum tube which connects directly with the carburetion chamber of the carbureter *C*, of ordinary but highly simplified design. The crankcase forms a partitioned oil reservoir with splash action, but a force system is used in addition. At 1100 r.p.m. the Miller motor, with four cylinders of 100 mm. bore and 130 mm. stroke, gives close to 40 horsepower, and at 800 r.p.m., which should correspond to about 30 horsepower, the fuel consumption was found to be 11.650 litres for one hour of 265 grammes per horsepower, which is as low as for good motors of much heavier construction. The weight of the Miller is 70 kg., but the lightness is the result of the choice of type rather than of any skimping in the dimensions of parts. *La Vie Automobile* mentions the fact that this is one of the few motors for aviation whose makers furnish a propeller designed especially to agree with its power and speed, thus recognizing the great loss of efficiency which follows when the matching of these two elements is left to chance or must be effected by gearing.

The combination of the revolving with the two-cycle type offers an opportunity to dispose centrally of the exhaust. This is done in the German Palous & Beuse motor by means of a pocket in the edge of the pistons, which is arranged to register with an outlet port at the end of the downstroke, on the plan of the auxiliary exhaust of several air-cooled automobile and two-cycle marine motors. The P. & B. aviation motor has four revolving cylinders of 150 mm. bore and 140 mm. stroke, completely valveless, and weighing, everything included, 1 kg. per horsepower. The construction is shown in two sectional views. The manner of operation is as follows: The gas mixture is ignited when the piston 19 reaches the top of the

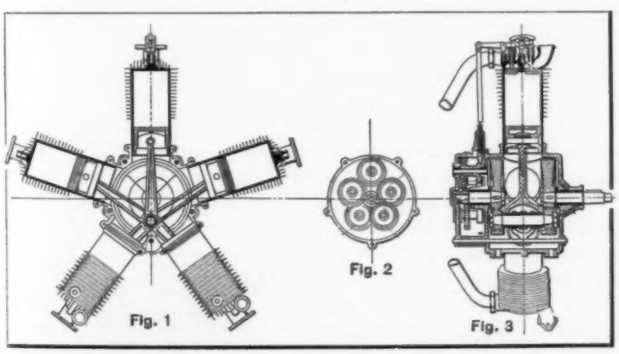


Fig. 8—Sectional view of the Anzani five-cylinder, four-cycle motor

stroke, but meanwhile this piston has drawn in a fresh charge through the pipe 15, during the upstroke, and has filled the chamber 9 completely with the mixture. By the downstroke this charge in chamber 9 is compressed, and, after the piston has reached the entrance to induction pipe 15, the gases enter through this opening in the cylinder, and while this takes place the exhaust port is also becoming free, as above referred to. The ignition, as well as the regulation of the gas mixture, takes place through the curved aperture 8, which is opened and closed by a fibre ring 7, on which the ignition roller rotates. The carbureter is of the spray type, without float. While the cooling is effected mostly by the rapid revolving of the cylinders without recourse to flanges, the distribution and compression of the fresh charge all around the cylinder contributes to the desired effect.

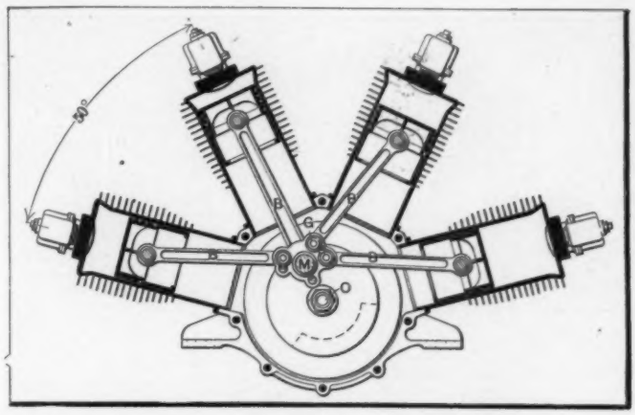


Fig. 4—General construction of the Miller motor

Anzani's two-cylinder, two-cycle motor, giving 30 horsepower, with a bore of 95 mm. and a stroke of 200 mm. (37/10 inches by 74/5 inches), and weighing 130 pounds, all included, is an air-cooled engine, but not of the revolving type. The cylinders are bolted to a vertically divided crankcase of aluminum in the usual way. The two pistons move together in the same direction with the two connecting rods attached to one crank pin. The internal flywheel is drilled to pare down weight. All gear wheels are avoided, the two-cycle system admitting of operating the exhaust valves in the heads of cylinders from a single cam on the crankshaft, and the magneto is also operated from the crankshaft. The accompanying sectional view shows the double bore of cylinders and the enlarged diameter of the lower end of the piston. At the head of the wide-diameter portion of the cylinders is a port into which is mounted an intake pipe with an automatic poppet suction valve, and the carbureter is on the middle of this length of piping. Each cylinder aspires the gas mixture for the opposed cylinder, compresses it, and drives it across through one of the two transfer pipes shown overhead, ready for use in the other cylinder as soon as its own power stroke is completed. By means of a very large exhaust valve, only one inch less in diameter than the bore, and by a one-fifth lead in the exhaust valve opening, mixing of the incoming charge with the exhaust is minimized. While this motor has been used largely on Blériot aeroplanes, there is a significant absence of reports with regard to its ability to remain cool, and Anzani has created another type which is a four-cycle, five-cylinder, star-shaped engine, weighing 176 pounds, and developing 50 horsepower. The cylinders are 105 by 120 mm. (4 by 47/10 inches) and are screwed into the crankcase. All the pistons work on a single throw crankshaft, each connecting rods clasping the crankpin in the usual way, so that all pistons have the same travel, unlike the Miller engine and other star-shaped or revolving cylinder motors in which only one connecting rod has the full length. The explosions in the Anzani five-cylinder motor take place in the order 1, 3, 5, 2, 4, at regular intervals of 144°, permitting ignition by high-tension magneto turning at 5/4 the speed of the crankshaft. Instead of a camshaft, there is a small pinion on the end of the crankshaft driving four independent pinions and cams, and a fifth pinion receiving its movement from one of the others, an arrangement which is probably dictated by lack of transverse space, but also serves the purpose of affording independent adjustment of the individual valves. The lubrication is by means of a pump driven from the crankshaft, with a collector to return excess oil find-

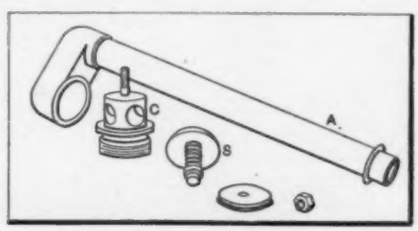


Fig. 5—Valve parts of the Miller motor

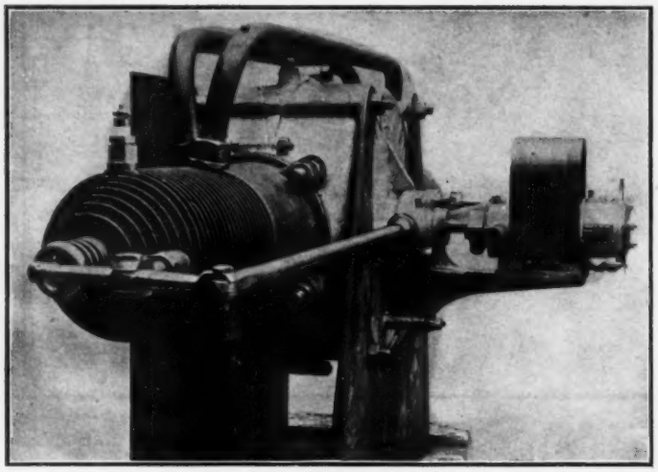


Fig. 7—Anzani's two-cycle, two-cylinder, air-cooled, 80 H.P. motor

ing its way to those cylinders whose heads are down. Both intake and exhaust valves are in the cylinder heads, and are operated by a double rocker arm similar to that used in the Panhard aviation motor referred to in this article. The carbureter consists of a cast aluminum choke tube mounted on an aluminum saucer, from the center of which rises a vertical nozzle. The base of the tube is provided with air openings and the gasoline flow is regulated with the conical-head screw shown in the illustration. In an aeroplane machine this screw is turned off or on by means of a Bowden wire. The weight of this carbureter is only a little more than one-half pound. In practice it sends a steady semi-liquid flow into the hot induction tubes. Its fuel economy is probably slightly better than that of the surface evaporators used in 1897, and its small weight is therefore more than counterbalanced by the greater amount of gasoline to be carried by the aviator for any but very short exhibition flights.

One of the most conservative aviation motors is the four-cylinder Panhard with which the Tellier monoplane is equipped, and with which flight records have been made quite equal to most of those made with motors of much lighter weight. As it is practically an automobile motor with copper water jackets, steel cylinders with separate heads and concentric valves, an illustration of the valve mechanism will serve the purposes of this article. The cylinder head is a Y-shaped casting, one arm of which is bored out to receive the intake manifold, while the

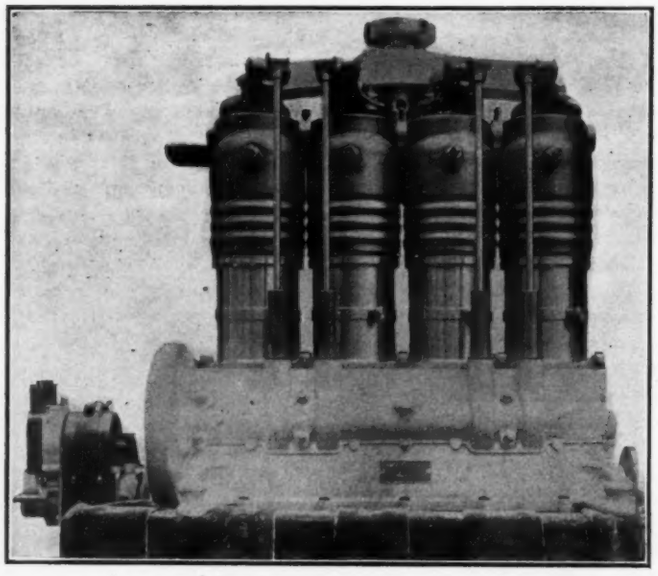


Fig. 9—The Panhard-et-Levassor aviation motor

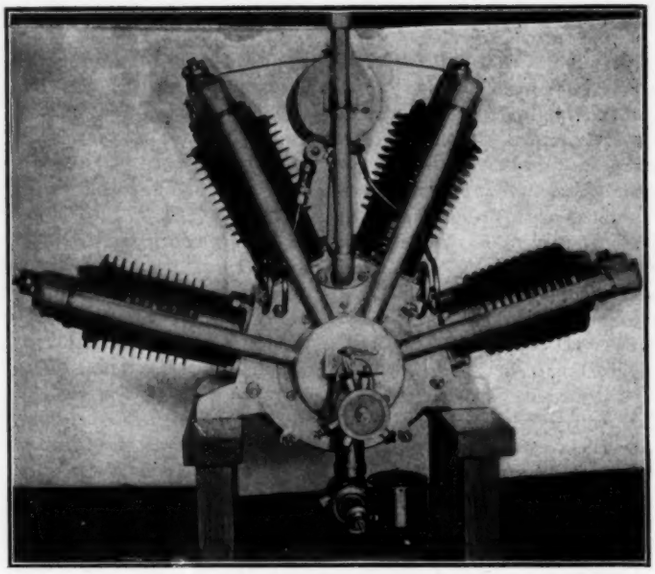


Fig. 3—The Miller aviation motor, built in Italy

other arm forms a bracket for the special rocker arm operating the two valves, and its stem is bored to house the valves. In the upper portion of this housing, with reduced diameter, is inserted a helical spring, which maintains the intake valve in position on top of the cylindrical exhaust valve bell, and into the top of the housing is screwed a cap, against which the external exhaust valve spring abuts, and which also carries a rocker arm, by means of which the intake valve is operated. While the short end of the rocker arm depresses the exhaust valve on the downward thrust of the main rocker, the long end raises the extremity of the short rocker arm, on the upward lift, and depresses the intake valve. Each pair of valves is operated by a single cam and a single tappet rod. The water-cooling connection between the cylinders is by means of a narrow rubber-bound collar, as plainly seen in two of the illustrations. This motor develops 40 horsepower, and it is worthy of belief in its stability on account of the service already rendered by the type, resulting in efficiency of performance and high thermal results. It is stated that the fuel consumption is only 3 gallons per hour at full power.

For a considerable time the seven-cylinder Gnome motor held the position as the most pronounced deviation from current practice, both with regard to lightness and design, and it has been frequently described. The cylinder walls are only ½ mm. thick, or about one-fortieth of one inch, though bore and stroke are approximately 4½ inches and the centrifugal strain arising from the very rapid revolving of the whole engine must be very considerable. The cooling flanges contribute greatly to strength, however. When running full power this motor makes a thundering noise, and sends smoke and greasy spray in all directions, radially, as the exhaust is in the seven cylinder heads and passes out unchecked, while the lubricant is either a mixture of mineral and castor oil, or pure castor oil, which has to be supplied in profusion. The power development reaches 50 horsepower, however, with a total weight of 150 pounds. The inlet valves are in the pistons and are auto-

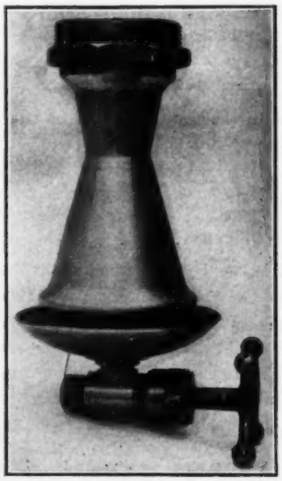


Fig. 12—The floatless carbureter of the Anzani motors

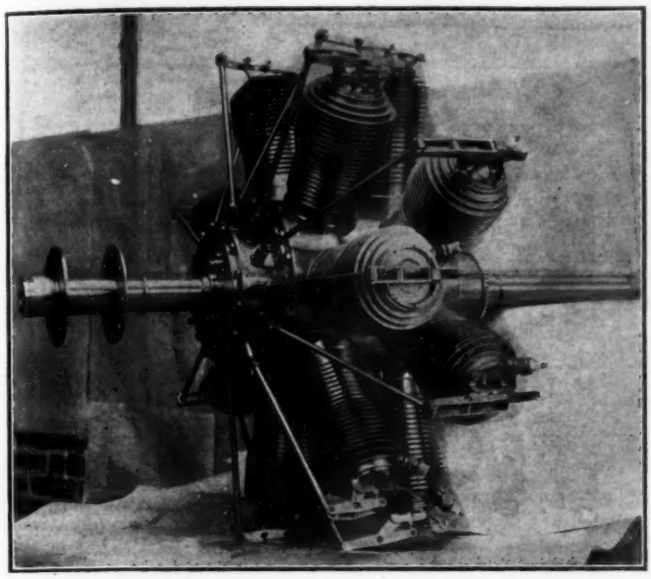


Fig. 13—Gnome 14-cylinder revolving, four-cycle, 100-hp. motor

matic. The pistons, by the way, are provided with only one cast-iron piston ring each, close to the top of the piston, but this single ring is surrounded with a ring of L-section spun from a strip of brass and kept expanded by the pressure of the cast ring. The inlet valve is of the ordinary mushroom type, but its stem is engaged by a pair of levers which ter-

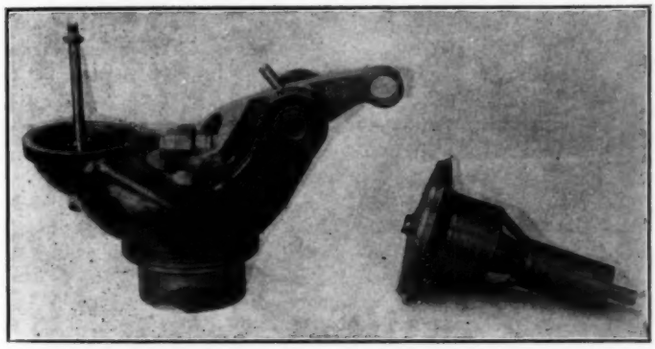


Fig. 11—Cylinder head and concentric valves of Panhard motor

minate in counterweights arranged to counteract the tendency to opening of the valve which naturally results from centrifugality. The faster the motor revolves, the harder the counterweights press upon a flat spring which serves as valve-closing spring. The effects are balanced so nicely that the centrifugal action is neutralized and the suction of the piston, in drawing in the gases

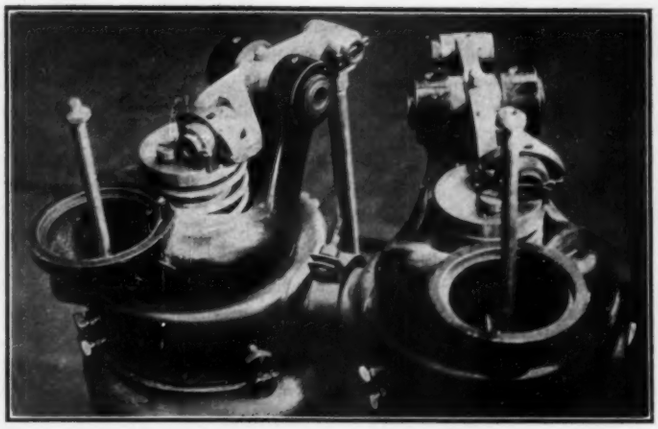


Fig. 10—Valve-operating mechanism of Panhard aviation motor

has no more nor less work to do in overcoming the valve spring than if the motor were not of the revolving type. With keen logic the designer has perceived that the inaccessibility of these valves would not matter, as the aviator, anyway, has no time to fix a valve giving trouble.

This motor has now been distanced by a 14-cylinder Gnome of the same general construction, but in which the effects of a gasoline turbine are even more strongly marked. The horsepower is increased to a round 100. It is practically a double seven-cylinder Gnome, one placed staggered in relation to the other on the common crank case, for each has its own magneto and its own lubricating pump. The operation of all the valves from the same side, despite the far-over reach for one set of the valve rods, unites the two motors into a single engine to the eye, and the whole weighs 260 pounds, being a weight saving of 40 pounds, as compared with doubling the weight of the seven-cylinder species. The circular crankcase is machined from a steel casting, and each cylinder is secured in position by means of an internal-locking ring. The crank pin, which is single in the seven-cylinder motor, is here double-opposed, with seven connecting rods acting on each crank. The whole mass of cylinders and valve-operating parts revolves around this shaft mounted upon two ball bearings. The carbureter is a brass elbow, with a series of air holes, surrounding a spray jet and provided with a mechanically operated sleeve giving additional air for starting cold, and a butterfly throttle valve. The motor can be throttled down to run at 300 revolutions. The gas mixture is drawn through the hollow crankshaft into the crank case, where it is acted upon by the automatic intake valves. Lubrication is also effected through the fixed crankshaft by means of two copper tubes passed through the same and fed from two force feed pumps. The pure castor oil, which is the material preferably used, passes to each of the two sets of cylinders through fine perforations in the shaft.

Abstracts from the 50 Best Foreign Papers

Digest Along Technical Lines for Engineers

Methods for joining aluminum parts, other than by flanging and riveting, are reviewed with the special object of determining the maximum strength of true soldering joints. With regard to autogenous welding, Spring has shown that two pieces of aluminum heated to 400° C. and pressed together are slowly united. W. C. Heraeus, of Hanau, heats pieces of aluminum by means of a hydrogen blower and hammers them together. In this manner tubes are formed almost equal to drawn. Rapid oxidation is the greatest hindrance to soldering and welding. When metallically clean, aluminum at once takes on a film of oxide which effectually prevents the uniting with another piece of metal coated likewise. There is needed a flux to prevent or dissolve this formation. The "Autogen" Company has a process for dissolving the oxide and forming a slag which isolates the weld-place airtight. For true soldering a great number of solder preparations are used corresponding to the great number of aluminum alloys in the market. A. Minet states in *L'Electrochimie* that Otto Nicolai uses a zinc-tin alloy and gets firm joints by covering the solder-place with powdered chloride of cadmium or iodide of cadmium. This is believed to be the process re-

ferred to later in the tests of "Grubelin" flux. Dr. Edw. D. Self says the skin is a film of clay, but gets results, by using vaseline or paraffine as flux, with any one of four solder alloys: (1) One part silver and two parts aluminum; (2) 85 to 95 parts tin and 15 to 5 parts bismuth; (3) 99 parts tin and 1 part bismuth, but this is improved by adding 1 part aluminum; (4) 90 parts of tin, 5 parts bismuth and 5 parts aluminum. He states that good cleaning and cautious heating (not exceeding requirements for fusion) are necessary and that the solder should be put on with a soldering iron. W. S. Bates stated before the American Chemical Society at Chicago that 70 parts of aluminum and 30 parts of tin gives a very firm joint, but that in course of time the molecules change their positions and the joint gives way; also that 81 parts of aluminum with 19 parts of copper, while not so fusible as the other composition, makes a lasting joint. But the best results, Bates says, are obtained with 70 parts of aluminum, 20 of tin and 10 of copper or silver, and a joint made with this solder proved perfectly durable and was not affected by immersion in water for two months. For the soft solders, Bates used as a flux chloride of zinc, stearin, soap, sugar, chloride of mercury and some iodides; for the hard solders and higher temperatures he used borax, fluoride of alkali, chloride of lithium.

Some time ago a ready-to-use aluminum solder, together with a flux designated in trade as "Grubelin," was brought into the market. The fusion point of the solder is 230° C. or no higher than that of tin. With this, it seems, sheets, tubes, wires and even cast pieces may be joined strongly and lastingly. By reason of the low melting point, even sheets and wires not more than one-tenth of one millimeter in thickness may be soldered. In using this process, the work is cleaned with a scraper, not with sand or emery, and heated by means of a Bunsen burner or a blowpipe, small pieces of the solder being placed on the work after the latter has been sprinkled with the flux. But the work may also be done as soft soldering, the solder being rubbed on with the heated soldering-iron till the surface is covered. By the rubbing, the oxide skin just formed by the heat is removed.

This was tried in the Royal (Prussian) Laboratory for Testing of Materials, with aluminum sheets bought in the open market. Strips of 30 mm. width were cut from the sheets and soldered with varying overlapping. A scraper was used to brighten the surfaces, and the areas were at once covered with solder, a copper wire being used to distribute it. The two areas were placed against each other, held with two tongs and heated over the Bunsen burner. As soon as the solder began to melt, the copper wire was used to apply a little more of the solder along the edges of the seam, and then the work was allowed to cool under the pressure of the tongs. The soft soldering part of the test was carried on in the customary manner, but without sal-ammoniac or water. To obtain a basis for judging the strength of the joints, the strength of aluminum strips 30 mm. wide was first determined in their original condition and subsequently after they had been heated in the Bunsen flame. The result of this was as follows:

Sample No.	Condition	Measurements			Breaking Load	
		Width cm.	Thickness cm.	Area of Section sq. cm.	Observed kg.	Tension kg per. sq. cm
1	As bought	3.0	0.05	0.15	330	2000
2	As bought				317	2100
3	Heated over				132*	880
4	Bunsen Burner				164	1090

From this it is seen that the aluminum sheet loses about one-half its strength in being heated for soldering, and consequently the soldered joint must for this reason alone be weaker than the sheet in its original condition. Probably the rolling process gives the sheet the higher strength which it loses by heating. The data of the solder joints are given in the following table:

*Was broken by adjustment in the machine.

Sample No.	Dimensions of Seam		Method	Done by	Breaking Load		Location of Fracture
	Length cm.	Width cm.			Observed kg.	Tension kg. per sq. cm.	
1	1.8	3.0	heated over Bunsen burner	by inventor of process	156	1040—1	—1 = outside the soldered area.
2	1.2				158	1050—1	
3	1.6				150	1000—2	
4	1.0				136	910—2	—2 = in the soldered area.
5					156	1040—1	
6	1.0				148	990—2	—3 = in the seam
7	1.0				138	920—3	
8	1.0				134	890—3	—4 = in seam when adjusted for test.
9	1.0		with soldering iron	by locksmith employed at test station	...	—4	
10	1.0				50	330—3	
11	1.0				...	—4	
12	1.0				156	1040—2	
13	1.0				66	440—3	
14	1.8		cautiously over Bunsen flame		258	1720—1	
15	1.2				214	1430—2	
16	0.6				200	1330—1	

Samples 4 to 8 and 9 to 13 were produced by soldering two sheets of 16½ cm. width to one another, so that a seam was made of 16½ cm. in length, and these sheets, so joined, were then cut in strips of 3 cm. in width, with the seam in the middle. The tests show that the firm joints may be made of sheets 0.05 cm. thick and that the strength of the joints, in the case of rolled sheets, depends on the heat. Sample No. 14 gave the best results through very cautious soldering, the strength being reduced only 330 kg. per square cm., or 16 per cent. below the average strength of the sheets before heating, which was 2,050 kg. In other words, the soldered joint reached 84 per cent. of that of the material itself, while the latter by mere heating to red would have lost 50 per cent.

A very recent soldering method consists in nickel-plating the parts to be joined and then proceeding to solder with usual tin solder and soldering-iron. This method is, so far as experience has shown to date, dependable, besides being easy to carry out.—*Metall-Technik*, Nos. 20 and 21, 1910.

An immediate patina for copper and bronze, taking the place of the offensively bright metallic surface, may be produced at a pinch by very simple means. The method is not one that gives absolutely lasting results, as when an etching solution is used, but it is quicker and cheaper and lends itself to many variations in the shades. It consists simply in sandblasting the object until the metallic brightness has given way to a matt effect, then brushing into this matt surface powdered dry coloring matter, as fine as possible and of the main shade which it is desired to obtain in the finished article. Usually Paris green or chrome green with an addition of brown or black will serve the purpose; even a powdered brown alone will do. The metal takes a satiny appearance and a light after-brushing will remove an excess of color. There will always remain an adhering coat of coloring matter in the minute furrows and indentations caused by the sandblast. The object is then dipped in a bath of transparent varnish or shellac and left to dry in a dust-free drying room. The shellac does not only protect the coloring matter, so it will not readily wear off, but also imparts a lustre to it.—*La Vie Automobile*, July 9.

Complete independence of cooling methods is promised by Martin-Saxton, an engineer, who proposes to lengthen the cylinder to make the lubricated and tight-fitting lower portion of the piston work in the lower continuation of the cylinder, this continuation being isolated from the upper portion by a non-conductive ring, and on top of the lower portion of the piston to have a loose-fitting cylinder which is independent of lubrication.

Manual training at universities.—The university of Göttingen has made arrangements by which science and medical students may learn the practical parts of laboratory and experimental work at the manual training school maintained by the city of Göttingen. The courses for the students remain under the direction of the university authorities and are paid for through the latter.—*Werkstatts-Technik*, July.

Aviation News of the Week

FOLLOWING the line of experimentation laid down by Glenn H. Curtiss when he dropped fifteen out of twenty-two bombs within the outlines of a battleship while flying at full speed and at varying elevations in his aeroplane at Keuka Lake, the United States Government has just completed a lot of research work to develop the possibilities of the aeroplane as a military and naval factor.

The conclusions of the officers were that there is no firearm in existence that can cope with the perfected type of aerial torpedo craft and that such perfected aerial torpedo craft will become stable adjuncts of the navies of the world within five years.

In the way of protection, the tests were intended to prove that steel nettings or similar devices would shield ships, men or forts from bombs or torpedoes projected from aeroplanes. According to reports rendered to the War Department, the momentum caused the experimental shells used by the authorities to crash through a steel wire net so closely woven as to equal the resistance offered by a sheet of half-inch steel.

The main points urged by the advocates of the aeroplane are as follows: Small possible casualties; low cost; small target; invulnerability of machine and crew through simple protective armor; efficiency against ships, troops, or forts; mobility and facilities for gaining information of the disposition of an enemy's forces.

Inspection of aeroplanes is being seriously considered by the United States Government, according to recent announcement. The French Government is also about to install some sort of an inspection system.

An even dozen entries for the *World-Post Dispatch* prize of $30,000 for a flight between St. Louis and New York have been made or are about to be made. Among the entrants are the following: Harry S. Harkness with an Antoinette monoplane; Louis Strang, a Bleriot; Philip Wilcox, Joseph Seymore, George Russell, Tod Shriver, Walter L. Fairchild, and Israel Ludlow.

Clifford B. Harmon, who may make a try for the prize, is trying to influence Louis Paulhan to enter the contest, but on account of the legal tangle that followed the last attempt of Paulhan to aviate in this country, there is small chance of his doing so.

Rheims Aviation Meet Brings New Results

The complete official results of the second annual Rheims aviation meeting are as follows:

Grand Prix de Champagne offered to the builder whose three machines fly the greatest total distance

	Miles
Antoinette monoplanes, Antoinette 8-cylinder motor	1616
Bleriot monoplanes, Gnome 7-cylinder motor	1430
Henry Farman biplanes, Gnome 7-cylinder motors	1181
Sommer biplanes, Gnome 7-cylinder motors	850

Greatest Distance in a Single Flight

	Miles
R. Labouchére, Antoinette monop'ane, Antoinette motor	211
Olieslagers, Bleriot monoplane, Gnome motor	139
Tetard, Henry Farman biplane, Gnome motor	115
Cattaneo, Bleriot monoplane, Gnome motor	111

Note.—Last year's record, Henry Farman, 111 miles.

Gordon Bennett Elimination Race, 62 1-10 Miles

	Time
Alfred Leblanc, Bleriot monoplane, Gnome motor	1:19:13 3-5
Hubert Latham, Antoinette monoplane, Antoinette motor	1:24:58 3-5
R. Labouchère, Antoinette monoplane, Antoinette motor	1:25:24

Altitude Prize Brings Out Large Field

	Feet
Hubert Latham, Antoinette monoplane, Antoinette motor	4540
George Chavez, Bleriot monoplane, Gnome motor	3772
Morane, Bleriot monoplane, Gnome motor	2460
De Baeder, Henry Farman biplane, E. N. V. motor	1640
Cattaneo, Bleriot monoplane, Gnome motor	1345
Tetard, Henry Farman biplane, Gnome motor	1321
Lindpaintner, Sommer biplane, Gnome motor	1131
Louis Wagner, Hanriot monoplane, Darracq motor	961
Nieuport, Nieuport monoplane, Nieuport motor	298

Note.—Last year's record, Hubert Latham, Antoinette monoplane, 508 feet.

Military Officers' Competition, 31 Miles

	Time
Lieut Cammermann, Farman biplane, Gnome motor	:46:50
Lieut. Fequant, Farman biplane, Gnome motor	:47:40

Ladies' Prize, Not Heavily Competed For

	Miles
Mme. Delaroche, Voisin biplane	3

Passenger-Carrying Prizes—With One Passenger

Aubrun, Bleriot monoplane, Gnome motor, 85 miles in.. 2:09:07 4-5

Passenger-Carrying Prizes—With Two Passengers

	Miles
Mamet, Bleriot monoplane, Gnome motor	58

Note.—Last year's record, Henry Farman, 6 miles in :10:39 with two passengers.

Speed Tests, Distance 12 2-5 Miles

	Time
Morane, Bleriot monoplane, Gnome 100-h.p. motor	:12:45 3-5
Alfred Leblanc, Bleriot monoplane, Gnome 50-h.p. motor	:12:55 4-5
Olieslagers, Bleriot monoplane, Gnome 50-h.p. motor	:13:15

Average, 66 1-10 miles an hour.

Note.—Last year's record, Glenn H. Curtiss, :15:15 3-5.

Speed Tests, Distance 6 1-5 Miles.

Morane, Bleriot monoplane, Gnome 100-h.p. motor	:05:42 2-5
R. Labouchère, Antoinette monoplane, Antoinette 50-h p. motor	:06:31
Alfred Leblanc, Bleriot monoplane, Gnome motor	:06:33

Note.—Last year's record, Louis Bleriot, :07:47 4-5.

Speed Tests, Distance 3 1-10 Miles

Morane, Bleriot monoplane, Gnome 100-h.p. motor..... :02:48 2-5

Note.—No record for this distance last year.

Michel Ephrussi Cross-Country Race, About 18 Miles

	Time
Alfred Leblanc, Bleriot monoplane, Gnome motor	19:14 1-5
Louis Wagner, Hanriot monoplane, Darracq motor	:20:57 4-5
Nieuport, Nieuport monoplane, Nieuport motor	:23:22 3-5
Pischoff, Werner monoplane	:24:46 1-5
Lindpaintner, Sommer biplane, Gnome motor	:25:51 1-5
Marcel Hanriot, Hanriot monoplane, Clerget motor	:26:35
Aubrun, Bleriot monoplane, Gnome motor	:29:34 2-5

Michelin Prize

Olieslagers, Bleriot monoplane, Gnome 50-h.p. motor, 244 miles 5:03:05 1-5

Note.—Previous record, Henry Farman, 145 miles in 4:17:53.

Totalization of Heights (minimum of each 330 Feet)

	Feet
Hubert Latham, Antoinette monoplane, Antoinette motor	26,552
De Baeder, Farman biplane, E. N. V. motor	21,194
Morane, Bleriot monoplane, Gnome motor	14,225
George Chavez, Bleriot monoplane, Gnome motor	7,273
Cattaneo, Bleriot monoplane, Gnome motor	3 811
Tetard, Farman biplane, Gnome motor	3,248
Lindpaintner, Sommer biplane, Gnome motor	2,135
Louis Wagner, Hanriot monoplane, Darracq motor	1,856
Nieuport, Nieuport monoplane, Nieuport motor	747

Greatest Totalized Distances

	Miles
Olieslagers, Bleriot monoplane, Gnome motor	1,051
Weymann Farman biplane, Gnome motor	778
Fischer, Farman biplane, Gnome motor	720
R. Labouchère, Antoinette monoplane, Antoinette motor	716
Hubert Latham, Antoinette monop'ane, Antoinette motor	574

Coming Events in the Automobiling World

Dec. 1.....Chicago, Ill., First Annual Aeronautical Exhibition in the Coliseum.

Jan. 7-14, 1911...New York City, Madison Square Garden, Eleventh Annual Show, Pleasure Car Division, Association of Licensed Automobile Manufacturers.

Jan. 16-21, 1911..New York City, Madison Square Garden, Eleventh Annual Show, Commercial Division, A. L. A. M.

Jan. 28-Feb. 4, '11.Chicago Coliseum, Tenth Annual National Automobile Show Under the Auspices of the National Association of Automobile Manufacturers, Inc., Pleasure Cars and Accessories, Exclusively.

Feb. 6-Feb. 11, '11.Chicago Coliseum, Tenth National National Automobile Show Under the Auspices of the National Association of Automobile Monufacturers, Inc., Commercial Vehicles, Pleasure Cars, Motorcycles and Accessories.

Races, Hill-Climbs, Etc.

July 30.....Wildwood, N. J., North Wildwood Automobile Club, Speedway Races and Club Meet.

July 30.....Long Island Motor Parkway, Track Meet.

THE AUTOMOBILE

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WE believe that associations of bankers have the same right to combine against the automobile as the American Federation of Labor had to boycott the Buck Stove & Range Company. Gompers, Mitchell and colleagues are now facing serious action on the part of the Court for persisting along lines which are looked upon as in restraint of trade. Under the heading "Bankers Find Many Automobile Crazy" the New York *Herald* of July 22 printed a press despatch as follows: "Mount Vernon, N. Y., Thursday.—The Westchester Bankers' Association believe the people of the country are automobile crazy. On information received by its members at a session at the Briarcliff Hotel to-day, it was decided to look carefully into the applications of those who wish to borrow money on notes. If it is found that the applicant is to purchase an automobile, the bank will use extreme caution in discounting his paper. It was said that hundreds of persons have either mortgaged their homes or hypothecated valuable securities to purchase automobiles in the last six months." According to this Bankers' Association, a man who purchases an automobile is either lacking in sense or dishonest. It is of course gratifying to know that these bankers disapprove of dishonesty; it saves a bank examiner considerable worry to know that he does not have to watch a "string" of banks, but when a grave body of respected citizens makes the broad claim that purchasers of automobiles hypothecate valuable securities, the public at large will be justified in believing that they at least know the meaning of the word.

STANDARDIZATION, from the users' point of view, is a subject that has received but scant attention, due to the difficulty involved in combining the many opinions as they are voiced in the light of the experience of autoists, and to the further fact that makers of automobiles find it a sufficiently large task to bring about a condition of the standardization of the materials used in automobiles. Some of the illustrations presented in this issue of THE AUTOMOBILE are believed to be sufficiently terse to furnish a basis for thought, but it is not enough to merely ponder over a matter of such wide importance; the subject is ripe for action.

* * *

AT the pending meeting of the Society of Automobile Engineers one of the important subjects for discussion relates to the standardization of materials for automobiles. Naturally enough, engineers are sufficiently keen to understand perfectly the impossibility of bringing about a condition of standardization of cars on a broad basis before the materials used are reduced to a definite level. It is fitting that the question of the uniformity of materials be disposed of, and while this subject is far from new, the fact remains that much of the progress made by the Mechanical Branch of the A. L. A. M. was lost sight of during the last year or two, owing to inactivity on the part of the Mechanical Branch, and to a famine of material during the last year.

* * *

TO some extent, the scarcity of materials for automobiles was brought about through the lack of standards. The promiscuous ordering of materials, to the high disregard of stock sizes, introduced a high percentage of special work, and according to producers, made it unsafe to manufacture certain sizes for stock. If the Society of Automobile Engineers succeeds in establishing a set of standards for materials, producers will then be in a position to safely stock up, and the probability of a protracted famine will be materially reduced. Beyond this, a reduction in cost will be a reasonable expectation, and as a further benefit, the average of quality will mount to a higher plane.

* * *

IN reviewing the life and work of the Society of Automobile Engineers attention is called to the diversity of the subjects that received consideration, and a closer study for purposes of estimating will lead to the conclusion that the working of the Society has had a marked influence on the reform of steel mill practice. It has always been claimed that American steel fabricators stood for quantity production, and that they preferred to disregard questions of quality in the absence of quantity. This was another way of saying that the quality of American product was not up to the highest standard. Persistent work on the part of the members of the Society, coupled with the understanding that the good steel would be purchased from abroad if it could not be had from fabricators in this country, furnished the necessary inducement, and as it stands to-day the American mill is endeavoring to suppress its longing for tonnage sufficiently to make a foothold for quality. Great progress has been made and it now looks as if the time will soon be here when standard grades of steel will be regular from American mills.

RATIONAL conclusion in body designing is one of the subjects in this number, and it suggests a line of thought that must be uppermost with the men who participated in the late Glidden Tour, and with autoists in general who have had experience beyond the confines of paved streets and improved highways. It is a well appreciated fact that cooling, for illustration, is not a difficult process when an automobile is traveling at a high rate of speed, so that the only time when the radiator is likely to be overworked is when the car is traveling at a low rate of speed on an upgrade, or when the car is standing at the curb and the motor is slowed down with the spark retarded. Hooding over the front of the car, then, is advantageous in that splashes of mud are not permitted to destroy the radiating value of the cooler surfaces, nor is the low temperature of winter time likely to induce a considerable repair bill due to freezing water, whereas the relatively small opening, as shown in the hooded front, is sufficiently large when a fan propels the air as it does at low speeds. In the Glidden Tour improvised methods obtained for this purpose, but in the Prince Henry Tour the cars were so designed that the radiators were protected.

* * *

STRANGE to relate, the average autoist takes kindly to an aggregation of accessories plastered all over the exterior surfaces of his car; he overlooks the fact that at some time or other in his past one of the scenes that made an indelible mark on the tablet of his memory was the old-fashioned peddler and his store on wheels, with pots and pans dangling from hooks, placed with such a fine display of ingenuity that not a space remained uncovered. It is not believed that the peddler's wagon was regarded as a work of art; it was simply curious.

* * *

IS the peddler's plan a good one to be adopted for the automobile? But, if it is, are there not almost insurmountable disadvantages? The peddler kept an eye on his wares, despite the fact that a purloiner would scarcely be able to carry away more than a dollar's worth if he loaded himself down. In the case of the automobile, if nimble-fingered gentry succeed in appropriating a tire, to replace same will make quite a gap in the sparse pocketbook of the man who economizes for the purpose of buying and using an automobile. There are other angles to this problem. Tires depreciate quite as rapidly when they are hung on the side of the car and the sun beats down upon them as they do when they are serving their useful purpose on the wheels. One of the points brought out in this study of a body, as presented, is the fact that the spare tire can be placed in a dark and safe storage compartment, where it will keep without deteriorating, and the nimble-fingered purloiner of other people's property will give one disdainful glance at the body so arranged and take himself away empty-handed, he being afraid of work.

* * *

WHEN the chauffeur holds the wheel the owner sits in the tonneau and enjoys himself, he having the friendly protection which the tonneau affords; but when the owner drives he finds himself in a more strenuous atmosphere, and despite the protection offered by gloves, the hands get cold, and steering at the higher speeds becomes a dangerous occupation. Disregarding the fact that the chauffeur becomes hardened to his life, and exposure is less of a detriment, it remains to be seen that automobile bodies can be so designed that to occupy the front seat is quite as pleasurable as to lie back in the tonneau. The coming of the torpedo type of body was the last straw that broke the camel's back separating the automobile from its predecessor, the horse-drawn vehicle.

* * *

IN the engineering section a method of predicting the efficiency of internal combustion motors is presented with as much freedom from complication as can be expected in view of the importance of the subject and the complex thermo-dynamic problems involved. Certainly the time has arrived in the career of the automobile engineer when to build a motor first and find out afterwards whether or not it is good should be labeled as a high crime. The fact that a motor is made in the exact image of some other design, even though the model taken seems to be a work of art, is not sufficient ground for assuming that a condition of finality obtains.

* * *

IT is impossible to copy the design of a motor and obtain precisely the same results as those which are available to the original designer, because there is no way of taking advantage of the reasoning process which must be entered into by an original designer; hence danger besets the plan of the copyist, and success, instead of being assured, is represented by a tantalizing mirage, because while it is possible to copy the form, there is missing from the effort not only the precise materials used, but the condition in which they reside as well.

* * *

SMALL automobiles, once so prevalent in America, find favor abroad. When the foreign maker builds a big "road locomotive" he has a cast in his eye which reflects an American millionaire as a prospective customer, but when he builds an automobile for the native clientèle he puts a pair of blinds over the cast and designs on a basis of fuel economy, which is the paramount issue abroad. But it is not in the fuel economy alone that the small automobile sells. The depreciation of a car is in proportion to the power of its motor, or to the square of its speed on the road for a given weight, and in proportion to the weight, all other things being equal.

* * *

THERE is one other point that the foreign designer keeps in his mind's eye when he builds for home consumption. He remembers that the depreciation of an automobile is largely affected by its weight and speed, and that the life of the car is measured by the length of time it will serve silently, rather than by the distance it will make before it breaks down. In order to accomplish the intended purpose the parts are fashioned in such a way as not to court lost motion; they are protected from the accumulations of the roadside, and the method of lubrication is given the minutest scrutiny. It will be worth while for the American patrons of foreign products to notice the fact that they are the subjects for special consideration, but the time may arrive when the cost of maintenance will go up, due to the price of repair parts.

Possibilities of Automobile Construction

By HOWARD E. COFFIN, President Society of Automobile Engineers

THERE are many novel vital problems involved in automobile engineering and manufacture. The vast amount of experiments and testing necessary to bring the art to its present stage must be greatly added to.

Nearly all European and American pioneer automobile inventors, designers and builders started in the same general way. For sound engineering reasons certain paths of merit have been followed. As a result of many years' work by the best engineers, a popular design for large cars has resulted, after long trial of different features of construction separately appearing in early vehicles, such as the joint production of Peugeot and Levassor in the early nineties, and the production of Renault, Maybach, Bouton and some American engineers. The past several years have seen a substantially standard arrangement in small cars, so far as the principal component elements are concerned; here other features more largely the production of American engineers are dominant.

Prior to 1906, when the American automobile really began to reach its present high development, automobile engineers hesitated to co-operate openly, though they had followed the work of the contemporaries with interested closeness. Knowledge from the experience of others had greatly benefited the industry. Such blind co-operation exists in every industry.

Since 1906 open, frank discussion between automobile engineers has resulted in their mutual benefit and the benefit of the public. Realization that many heads are better than one brought through open discussion of the competent, newer and better methods of automobile construction.

There is no possibility of the Society of Automobile Engineers becoming a trade adjunct, but through its committee work and recommendations for standardization in specifications and materials, much practical benefit will result to the trade and the public; the technical value of the society to its members as a result of the presentation and discussion of theoretical papers, research work, etc., at the same time being continually increased.

No one of intelligence will to-day controvert the statement that all things in automobile engineering which can be, should be standardized—those things, the uniformity of which in no way stifles meritorious originality of design, but facilitates economic production and benefits the public. Many specifications for materials, and the method of treating and testing them, are standard; and there will be many more such specifications. Much good work in the way of simplifying seamless steel tubing specifications has been done; more of which will follow soon. The "deliveries problem" in the sheet metal field will be much less imposing within a relatively short time. There is a demand for standardization in the case of wood wheel dimensions and fastenings for solid tires; lock washers, brake and clutch levers; the various articles for the supply of which automobile manufacturers depend on automatic screw machine companies; round cornered square holes, spring shackle bolts; clutch leather.

There is an almost limitless field for good and an immediate necissity for action by way of standardization or such co-operation on the part of automobile engineers as amounts to the same thing. The automobile industry has sprung up like a mushroom, outstripping the detail engineering development which normally accompanies gradual growth. Lack of concerted work on the part of engineers, of standard reference tables, disregard of uniformity in material specification, can only result in greatly increasing the already existing great amount of needless expense, delay and vexation of automobile production.

A. A. A. Contest Board Disqualifies Buicks

At the last meeting of the Contest Board of the A. A. A., with Chairman S. M. Butler presiding, action in the matter of Buick models 16A and 16B was taken, disqualifying such models in all stock contests in which they participated during the race meeting at Indianapolis Speedway July 1, 2 and 4.

As cars of these models finished first in several of the races, the ruling will change the ownership of a number of purses and prizes and the effect on the general automobile contest situation may be radical.

The matter of the competence of Buick models 16A and 16B to enter stock car events was first brought into question at the Spring meeting at Indianapolis, when the cars were disqualified prior to the start. W. C. Durant, of the General Motors Company, made a sharp protest at that time, but was overruled by Chairman Butler.

When these cars were allowed to start in the recent races at Indianapolis it was supposed that the status of the models had been established, all of which adds to the suddenness of the blow. Mr. Durant left New York for Flint, Mich., early this week and nothing concerning the attitude of the General Motors Company could be learned, in his absence from the New York offices of that concern.

Mr. Butler, while making the announcement officially, would not comment upon its possible effect.

The general impression along Automobile Row was that the ruling is the first gun in what may prove a general engagement, the outcome of which may be a new alignment of the forces of motordom.

The possibilities involved are of such deep moment that few responsible leaders of the trade would hazard an opinion upon the matter.

Maryland Refused Motor Reciprocity

Baltimore, Md., July 25—Through Highway Commissioner Joseph W. Hunter, Pennsylvania has refused Maryland's overtures for reciprocal relations. In his letter to Motor Vehicle Commissioner John E. George, Mr. Hunter states that no matter what concessions Maryland may make, he has no authority to waive any of the provisions of the Pennsylvania motor car laws. This means that Marylanders who desire to pass through Pennsylvania or go to points north will have to pay the annual $10 license fee.

Marylanders will be at the same disadvantage that the laws of this State place upon Washingtonians. Persons in the District of Columbia are refused under the Maryland law a limited license at a reduced price for those who wish to go through Maryland. Thus Maryland seems to be getting a dose of its own medicine in consequence of the decision of the Pennsylvania authorities.

The District of Columbia authorities, because of Maryland's decision, have decided that Maryland motorists will have to pay $2 every time they want to go to Washington or pass through the District. And the motorists of all the States and sections are the ones who have to stand the hardship.

New speed rate notices have been designed by Special Officer Noah Walker, of West Arlington, to be placed along Park Heights avenue, the most popular thoroughfare out of the city. These signs explain the rate per hour permitted under the new law. The signs are of galvanized iron, circular in shape, a foot and a half in diameter. They will be placed on iron posts protruding less than two feet above the ground along the side of the highway. One side is painted bright red, while the opposite side is worded in large black letters with a bright yellow background.

Syracuse "Instructive" Run Proves Enjoyable Affair

SYRACUSE, N. Y., July 25—The Automobile Club of Syracuse held last Wednesday its first contest for the B. E. Watson trophy, donated by a member of the club. It was an instructive run, so called, based upon the provisions of the new automobile law which takes effect in the Empire State August 1. A secret time was established by a committee of which President Hurlburt W. Smith was chairman.

Start of Watson-Cup Run from Syracuse Court House

The time, based upon all requirements of the new law, was fixed at 6:07 3-4 for a run from the Court House here to the Spring House at Rexford Falls, where dinner was taken, and return. The cup was won by T. E. Lawless, one of the new members of the club, in 6:06 3-4, just a minute faster than the set time.

Mr. Lawless's car was a Maxwell. Miss Nettie Grody won, with a Pullman, a handsome silver cup donated perpetually by the club to the woman driver coming closest to the secret time. Miss Grody's time was 6:03. Mrs. Henry E. Mills, in a Franklin, was next among the women with 5:50. There were three other women drivers. The men finishing nearest to Mr. Lawless's time were W. J. Latimer, 6:02, and F. L. Wightman, 6:10.

Thirty-seven automobiles started, carrying 173 people, and all finished. The total value of the cars making the trip was estimated at $111,000. No confetti was used in the trip to mark the way.

Ideal weather conditions prevailed, the roads were in fine condition, and the route was pronounced one of the most picturesque in the State.

A feature pleasantly noticeable was the interest displayed by residents of the villages through which the automobiles passed.

The mechanical experts on the trip considered it a good, hard test for the cars, some of which were four or five years old, and that the run was made with a total of four punctures, forming the entire list of mishaps, was considered a splendid commentary upon general automobile construction of the present day.

The official summary follows:

No.	Name	Car.	Time
1	H. W. Smith (non-contestant)	Packard	....
2	B. E. Watson (non-contestant)	Oldsmobile	....
3	M. C. Smith	Amplex	5.06
4	George E. Messer	Franklin	5.14 1-2
5	H. W. Chapin	Thomas-Detroit	5.02 1-2
6	P. B. Ward	Winton	6.21 1-2
7	Charles Ludwig	Cadillac	5.35
8	P. E. Peacock	Buick	6.17
9	A. T. Brown	Packard	5.10 3-4
10	H. D. Weed	Speedwell	5.25
11	Strait & Shaw	Welch	5.36
12	D. Millen	Buick	5.35 3-4
13	R. P. Byrne	Speedwell	6.14 1-2
14	J. J. Barber	Pierce-Arrow	5.39
15	Mrs. L. P. Kellogg	Buick	5.39
16	Miss Nettie Grody	Pullman	6.03
17	Mrs. H. E. Mills	Franklin	5.50
18	G. L. Mardin	Selden	5.57 1-2
19	Charles A. Smith	Oldsmobile	5.58
20	A. M. Chase	Chase	5.45
21	E. L. Wright	Maxwell	5.51 1-2
22	A. J. Conine	Buick	5.46 1-4
23	F. L. Wightman	Winton	6.10
24	E. C. West	Stoddard-Dayton	5.59 1-2
25	George J. Arnold	Cartercar	5.47
26	Mrs. J. E. Heffernan	Knox	5.43 1-2
27	George J. Hessler	Franklin	6.16
28	W. J. Latimer	Buick	6.02
29	W. L. Brown (non-contestant)	Interstate	....
30	T. E. Lawless (winner)	Maxwell	6.06 3-4
31	Mrs. Susan Millan	Packard	5.43 1-2
32	H. H. Baker	Pullman	5.21
33	Dr. Albert Fisher	Selden	5.54
47	C. A. Benjamin (non-contestant)	Packard	5.21
48	H. F. Smith	Franklin	6.33 1-2
49	N. C. Hyde (non-contestant)	Chalmers-Detroit	5.40 1-2
50	F. Wilkinson (non-contestant)	Franklin	5.45 1-2

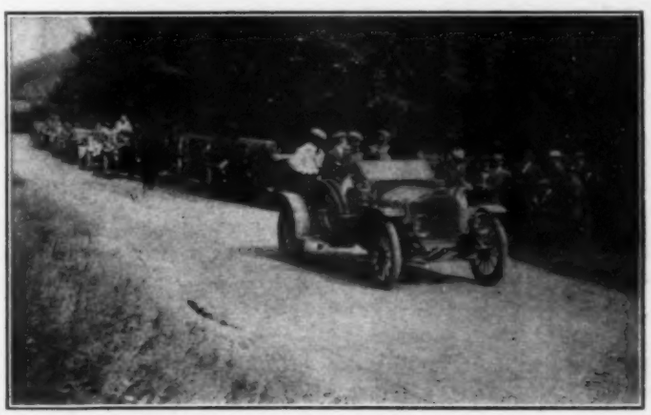
Bay State Notes of Automobile Interest

BOSTON, July 25—The Massachusetts Highway Commission is having completed this year about 50 miles additional of State highways that will fill in gaps here and there on through routes, and when the work is ended it will be possible to go from Boston to many large cities without leaving the State roads.

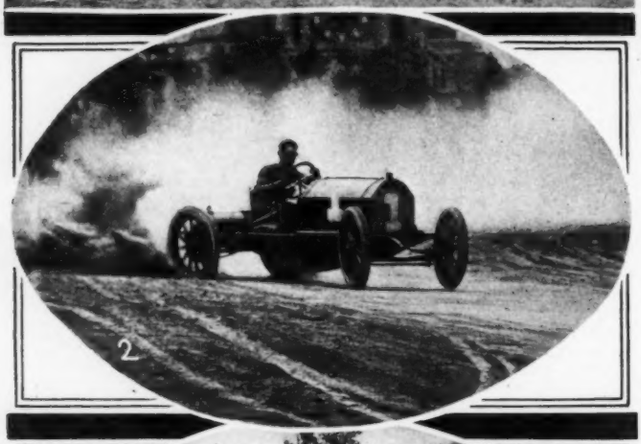
The South shore roads are getting much attention and very soon it will be possible to motor from Boston clear to the end of Cape Cod, returning by way of Buzzard's Bay, all on State roads, except where small villages are passed. The roads running through the center of the State are now nearly finished, while the northerly ones touching New Hampshire have been completed for some time. New Hampshire has made much progress with her State highways that come down to meet the Massachusetts roads. And Maine has taken up the work and appropriated a large sum to construct a decent road from the New Hampshire line through to Portland. That particular road has always been dreaded by motorists who knew its conditions, and many of them went to New Hampshire rather than go over it to Maine. These improvements will make motoring more of a pleasure to New Englanders and attract many visitors as well.

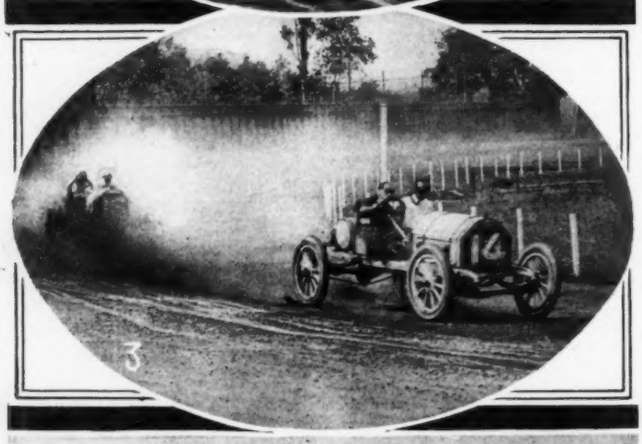
The Easton Machine Company has taken the salesrooms made vacant on Hereford street, Boston, by the retirement of the Hol-Tan company, as headquarters for the Morse car, made at Easton, Mass.

The Boston branch of the Winton company will be moved in December from the present quarters on Berkley street to a new building being erected on Commonwealth avenue in the vicinity of of the Packard, Buick, Peerless and Studebaker buildings. The new building will hold three motor companies, and C. F. Whitney with the Stoddard-Dayton and Alco cars will be another occupant. The Winton will occupy the center of the building.



First car in Watson-Cup contest returning to Syracuse





1—Start of Event 7, in which the Fiat beat the Simplex

2—De Palma's Fiat throwing a tire at head of the stretch

3—Lorimer's Chalmers leading the Beardsley Buick in Event 5

4—Louis Disbrow and the Marion, mile trophy winners

Brighton Beach Matinee Brings

BETWEEN 12,000 and 15,000 automobile enthusiasts paid admission Saturday to witness the program of nine races staged at Brighton Beach by the Motor Racing Association. The card was attractive and well filled, and there was enough incident and excitement during the afternoon to hold the interest of the spectators.

Caleb S. Bragg, in the amateur handicap event, proved the star of the matinee. Starting from scratch he pushed his big special Fiat along at a hair-raising speed and was picking up his field with ease when in making the turn into the stretch during the third circuit his car skidded and before he could regain control the radiator was butted through the infield fence. The driver kept his head and making a quick turn shot through the fence at a different point, took up the chase once more and managed to get to the wire ahead of his field by about 50 yards.

The duel between the Simplex "90" and the Fiat "60," run in two heats, the first of five miles and the second in two miles, resulted in a victory for the former. In the first heat the Fiat led for three miles, when the Simplex, moving fast in the stretches and hanging close on the turns, caught and passed its rival, winning very easily in 4:41 3-5. As an indication of the margin the Simplex had in the final mile, it may be cited that the time of the fifth mile was 10 seconds slower than that made in either the third or fourth circuits. In the second heat the Fiat broke first and led for a mile and a quarter, when the Simplex collared its rival and came on to win by three lengths in 1:49 4-5, last mile in 51 4-5, a new mark for the track.

Tire trouble was plentiful in the match race and in several of the other events on account of a sharp edge at the head of the stretch, where the turn had been cemented and the cars were obliged to plunge off the cement at an angle that proved trying to the tires. There was an agreement in the match race that in case of tire trouble in any heat the heat might be run over. Both contestants were obliged to take advantage of the rule and the Simplex finished the first heat on flat tires.

The hour race was well filled and its running was sharply contested. The carded field consisted of eight machines, and while S. P. O. No. 17, which broke its steering knuckle in its class race, and the Buick No. 16, winner of its class race, were withdrawn their places were taken by the Croxton-Keeton and the Palmer-Singer. The Simplex "50" got away with the gun, trailed by the Palmer-Singer and No. 20, S. P. O. The rest of the field was close up, the tailender being the Croxton-Keeton, which took a position on the rail and plugged steadily along during the whole hour, going faster at the end than at the beginning. The Marion and the Cole "30" also trailed the early pace.

When the cars had settled down to hard work the Simplex was in front with the No. 20 S. P. O. second and the Palmer-Singer third. This order was maintained to the twentieth mile, when the S. P. O. was driven up to the pacemaker and in a fierce struggle managed to lead the Simplex down the length of the back stretch. There the S. P. O. had enough and after trailing for a few circuits limped around to the stable turn, where adjustments were made. During this process the car was lapped a couple of times and the Palmer-Singer succeeded to second place. The Marion came along steadily between this point in the race and the thirty-third mile and was lying in fourth position when the Simplex threw a tire, leaving the Palmer-Singer out in front with the Marion in second position. By the time the Simplex returned the Palmer-Singer was a mile and a half in front and it held the lead until the fortieth mile post, when it was taken to the pits for new tires. In the meantime the Simplex, coming with a whoop, assumed the lead again and held it to the end, winning by a fraction of a lap from the Marion, which appeared to be gaining slightly upon the winner. The Palmer-Singer despite its hard luck was third, while the Cole was fourth

Great Enjoyment and Success

and the Croxton-Keeton fifth. S. P. O. No. 20 was sixth and made the last mile two seconds faster than the winner. The Houpt-Rockwell was on three cylinders for 10 miles of the 43 it covered and the S. P. O. 23 retired with a score of only 18 miles.

The first event was between two Hupmobiles and was won by No. 7. The farther the cars went the greater was the lead of the winner. The final margin was over half a mile. The second was between a Cole "30" and a Patterson. The latter led most of the way to the tenth mile, where the Cole galloped away, winning by the length of the stretch.

The fourth found a field of five, including three S. P. O. cars entered by different owners, a Marion and a Correja. The Marion won a beautiful race from S. P. O. No. 23 and S. P. O. No. 20. It was in this race that S. P. O. No. 17 broke its steering knuckle. Correja was on three cylinders most of the way.

No. 16 Buick won the fifth event in a sharp drive all the way from the Chalmers entry. The Midland narrowly escaped accident, striking the fence at the head of the stretch, but continued to the finish. The seventh was captured by the Fiat "60," which took a winning lead after the fourth mile. The Simplex "50" was second and the Knox third with a quarter of a mile interval separating them. The Knox suffered severely from tire troubles and finished on two flat tires.

The Fiat No. 4 won the free-for-all with ease. The Knox was second and the Midland took the small end of the purse. Buick No. 16 appeared a certain contender for second honors until the eighth mile, when it retired. The Hupmobile completed eight circuits and The Only Car made two less.

A. B. Cordner was chairman of the racing committee and H. M. Swetland presided as referee. The summary:

Event 1, Class C, Division 1C—Awards: $100 to winner, $50 to second; ten miles—

No.	Car	Entrant	Driver	Time
7	Hupmobile	C. B. Derby	C. B. Derby	13:35 3-5
8	Hupmobile	H. J. Koehler	A. C. Dam	14:26 3-5

Event 2, Class C, Division 2C—$100 first, $50 second; ten miles—

3	Cole "30"	Colt-Stratton Co.	"Bill" Endicott	12:32 3-5
6	Patterson	W. P. Mallon	H. A. Neeley	12:44 3-5

Event 3, Special Match Race—Purse $500; first heat five miles; second, two miles—

5	Simplex "90"	Simplex Auto Co.	Robertson	4:41 3-5
1	Fiat "60"	Fiat Auto Co.	De Palma	
	Second heat—			
5	Simplex "90"	Simplex Auto Co.	Robertson	1:49 4-5
1	Fiat "60"	Fiat Auto Co.	De Palma	1:50 3-5

Event 4—Class C, Division 3C—$100 and Milo trophy, first; $50 second; ten miles—

21	Marion	C. E. Reiss	L. A. Disbrow	10:55 2-5
23	S. P. O.	S. E. Wishart	S. E. Wishart	11:11
20	S. P. O.	H. S. Lake	J. Juhasz	11:52

Event 5, Class C, Division 4C—Ten miles; first $100, second $50—

16	Buick	R. E. Beardsley	R. E. Beardsley	10:05 2-5
14	Chalmers	C. H. Page Co.	L. Lorimore	10:09 3-5
19	Midland	J. M. Boyle	Leo Anderson	10:40

Event 6—Five miles, amateurs; trophies for first and second; handicap—

4	Fiat (scratch)	C. S. Bragg	C. S. Bragg	4:46 1-5
24	Simplex (15)	James Doig	Doig	5:09 2-5
16	Buick (20)	R. E. Beardsley	Beardsley	
23	S. P. O. (30)	S. E. Wishart	Wishart	
25	White St. (55)	E. A. Bofinger	Bofinger	

Event 7, Class C, Division 5C—First $100, second $50; ten miles—

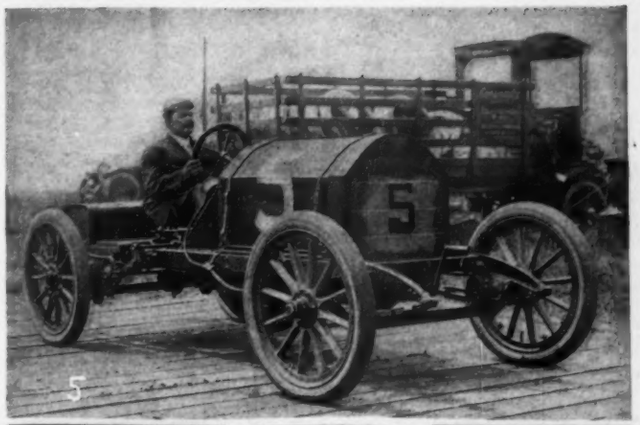
1	Fiat	Fiat Auto Co.	De Palma	10:00 2-5
9	Simplex "50"	Simplex Auto Co.	Robertson	10:10
2	Knox Giantess	Mrs. J. N. Cuneo	L. A. Disbrow	
18	Palmer-Singer	P.-S. Mfg. Co.	Harry Cobe	
8	Houpt-Rockwell	H. S. Houpt Mfg. Co.	S. Martin	

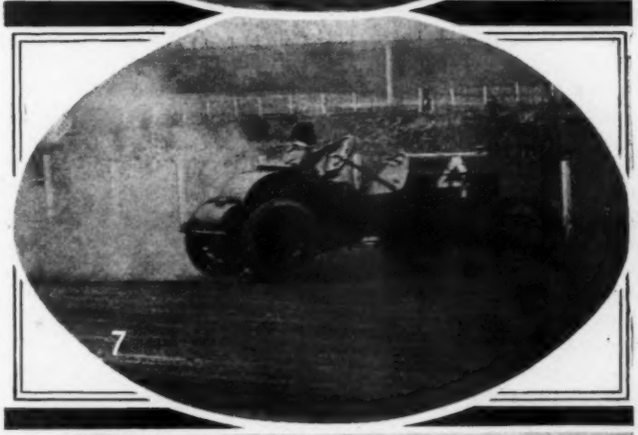
Event 8—Free-for-all—$200 first, $100 second, $50 third; ten miles—

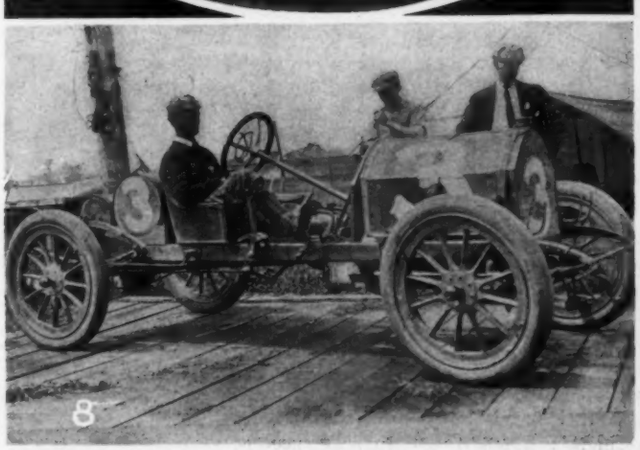
4	Fiat	C. S. Bragg	C. S. Bragg	10:09 1-5
2	Knox	Mrs. J. N. Cuneo	Disbrow	10:30
19	Midland	J. M. Boyle	L. Anderson	10:38 2-5
16	Buick	R. E. Beardsley	Beardsley	No fin.
8	Hupmobile	H. J. Koehler	A. C. Dam	No fin.
26	The Only Car	W. D. Gloat	Gloat	No fin.

Event 9—Hour race; $300 first, $150 second, $75 third, $25 fourth; and $200 gold watch to winner—

				miles
9	Simplex	Simplex Auto Co.	Robertson	53 1-2
21	Marion	C. A. Reiss	Disbrow	53 1-4
18	Palmer-Singer	P.-S. Mfg Co.	Cobe	52
3	Cole "30"	Colt-Stratton Co.	Endicott	51
12	Croxton-Keeton	C.-K. Company	W. C. Spenney	49
20	S P. O.	H. S. Lake	J. Juhasz	48
8	Houpt-Rockwell	H. S Houpt Mfg. Co.	S. Martin	43







5—G. E. Franquist, designer of Simplex 90 that won Event 3

6—Robertson, the Simplex driver, winning the hour race

7—Bragg going through the fence in the 10-mile free-for-all

8—"Bill" Endicott, who handled the Cole very cleverly

Detroit Hears of Electric Truck Plant's Coming

DETROIT, July 25—One of the most important expansions with which the local automobile industry has been identified in some time is foreshadowed by the announcement of President Walter E. Flanders, of the E-M-F Company, that the electric commercial vehicle plant of the Studebaker Manufacturing Company will be moved to this city from South Bend.

Immediately after the reorganization of the Studebaker-E-M-F companies, Mr. Flanders set about securing the consent of his associates to a centralization of manufacturing interests. The first step in this direction will be the establishment here of an electric commercial vehicle plant on an immense scale.

When the E-M-F Company took over the old DeLuxe plant and rebuilt it throughout as a home for the Flanders "20" most of the vacant property to the north was purchased, ostensibly for further expansion of the Flanders and constituent plants. Now plans have been prepared for factory buildings to house the newest addition to the local industry.

All that remains to be cleared up is the question of constructing a tunnel under the railroad lines dividing the property, through which to transmit power. When this is out of the way actual construction will be undertaken without delay, and it is stated that when completed the new plant will give employment to 2,000 skilled mechanics. This will make the fourth immense plant for the Studebaker-E-M-F interests in Detroit, the others being the E-M-F "30" plant on Piquette avenue, where new buildings are in process of construction; the Flanders "20" plant on Clark avenue, and a big factory on Franklin street. In addition there is a body factory at Pontiac and a large plant at Port Huron where rear axles for the "30" are manufactured.

This move puts an effectual quietus on unfounded rumors which have been circulated that Mr. Flanders contemplated resigning his present position and identifying himself with a new company. Mr. Flanders has strenuously denied this report, declaring himself satisfied where he is.

According to the State highway commissioner, Wayne County, in which Detroit is situated, has the finest roads of any county in the State. To those who have toured Michigan in unfavorable weather this may not seem like an achievement of which to boast; but the fact remains that within a short time all the principal thoroughfares leading out of Detroit will be in first-class condition, thanks to the activity of the county road commissioners. The paving of Woodward avenue has been completed to the county line, and Michigan, Gratiot and Grand River avenues, familiar to motorists the country over, are being improved as rapidly as possible. The Detroit Board of Commerce has taken the initiative in a move to secure a bond issue of $2,000,000 for good roads, and as an object lesson to unbelievers and to satisfy themselves about 100 members of that body indulged in a tour of inspection Thursday. What they discovered was plenty, and their findings will be incorporated in a report to be presented to the supervisors at an early date.

The resignation of Ernest Moross as general manager of the Indianapolis speedway has served to revive talk about a speedway for Detroit, on which Moross has long been figuring. Two or three sites have been under consideration for some time, and all that is necessary to make the undertaking assume tangible form is the financial backing. Whether that will be forthcoming remains to be seen, as in spite of the lead they hold in the matter of production Detroit makers have never been particularly partial to the racing game.

The Chalmers Motor Company has decided to withdraw from racing, in which it has been so successful, and the Hudson is counted among the new entrants.

Anent auto racing, the coming auto exhibit at the Michigan State Fair grounds will be further enlivened by races on Saturday of fair week, September 24. It is expected that the track, which is very fast, will be the scene of some good sport.

To accommodate employees in the new plant it will erect for the manufacture of Hewitt trucks in the northern part of the city, the Metzger Motor Car Company is preparing to build on a private right-of-way a half mile of street railway, running from Hamilton boulevard west to Twelfth street. The line will also connect with an extension of the Woodward avenue car tracks. Ground will soon be broken for the first of the buildings, which, it is expected, will eventually cover the entire 40 acres holdings of the Metzger company at this point.

Local automobile men are feeling the effects of the Grand Trunk Railroad strike in no uncertain manner, owing to the curtailment of accustomed shipping facilities in this quarter. Several of the larger plants are located on the Grand Trunk line, and the suspension of freight operations is alike hindering the receipt of cars for outbound shipments and the arrival of materials from outside points. Railroad officials give the assurance that the trouble will be brief and the fact that freight is beginning slowly to move bears out this statement.

The Charles H. Fuller Company has opened advertising offices in Detroit, with Martin V. Kelley and F. M. Randall in charge. Mr. Kelley recently disposed of his half interest in the McManus-Kelley Company, which removed to Detroit a short time ago, and F. M. Randall was associated with the Lord & Thomas Company up to the time of making this change.

What promises to be Detroit's biggest automobile show is scheduled for State fair week, September 19-24, when the motor interests will be found housed in a handsome new building, 125 by 275 feet, of two floors and affording ideal lighting conditions for show purposes.

There was a space drawing recently, and the entire ground floor went like hot cakes, being subscribed for in 30 minutes. Nearly every car handled in Detroit will be represented and the accessory firms are also showing interest in the display.

According to announcement, no expense will be spared to give the motor companies a suitable place to display their products. The new building will cost $40,000.

Progress is being made toward the completion of the various new motor car factories that have been in course of erection for the past two months or more, and early fall will see practically all of them in operation and working full capacity. Out in the Fairview district the new buildings of the Anderson Forge & Machine Company and the Hudson Motor Car Company, diagonally across from the Chalmers industrial group, are rapidly taking shape and have put an entirely different complexion on a district which, up to a few months ago, was nothing more than pasture land.

The Van Dyke Motor Company's new factory, 60 by 512 feet, at Campbell avenue and Leavitt street, has started operations and the first few of the 1,400 machines contracted for up to July 1 have been turned out. The plant has a capacity of 5,000 cars per year and for the present will give employment to 300 men. The new plant of the Grabowsky Power Wagon Company at Mount Elliott avenue and the Michigan Central Railroad, is almost ready for occupancy. Transportation facilities are such that 20 cars may be loaded at one time.

The Detroit United Railway moved into its new Woodward avenue barns in Highland Park last week and the Cadillac Motor Car Company immediately took possession of the old barns at Woodward avenue and Amsterdam street.

Announcement is made that the Small Motor Car Company is to be incorporated shortly with a capital of $200,000 for the manufacture of an underslung runabout car with a 25-horsepower engine of unit power plant construction. The bearing and cooling systems will be specially featured. The car will have a 100-inch wheelbase, 34-inch wheels and will weigh 1,400 pounds fully equipped. It is planned to manufacture the car in Detroit and Winnipeg.

Putting the Automobile House in Order

By COKER F. CLARKSON, General Manager Society of Automobile Engineers

A BIG task in automobile engineering lies right at hand. President Coffin, of the S. A. E., long ago suggested the adoption of definite terms for the multitudinous parts of the automobile, the component elements of which are denominated by various titles. This reform never came to fruition with the Licensed Association, having been sidetracked for other matters temporarily more important. The Society of Automobile Engineers is now entering upon this work.

Standardization is simply a matter of common sense, an absolute essential in bringing any important industry to its proper basis of efficiency in both production and replacement. Its accomplishment in its proper function can be brought about only by the utmost care on the part of those competent to pass on the particular matter in hand. The attention of the competent men must be had; and these men are abnormally busy in their routine duties. Much correspondence, detail work, discussion in committee and full meetings are necessary. Frequently a large amount of experimental data must be considered; often special tests must be made. But if the work be not done, confusion will become chaos. This is the history of every industry in which mechanical, as well as other, engineering is involved. The positive benefits of standards have been most clearly proved, as well as the many forms of vexation resulting from their nonexistence.

There are thousands of parts in any automobile. All makers of automobiles buy raw material which they form and machine into finished product. Their engineering departments must first specify more or less minutely the chemical composition or the physical characteristics required in each case before turning over orders to the purchasing departments. This specifying of the chemical properties or physical qualities is very largely a matter of standardization. For a proper working basis, it is necessary that the use of standard terms be established, bringing celerity and exactitude in specification. The engineering departments must specify dimensions of materials ordered. For this, standard reference tables, prepared in view of all the reasonable demands of design and of the inexorable facts surrounding sufficiently fast production of raw materials or parts, must be at hand. The point is that if the number of sizes of a given article be standardized down to a list representing the reasonable demands of the case, the article can be made better, more cheaply and more quickly, and therefore be delivered sooner. Anyone familiar with the workings of an automobile factory knows of the delays and complications attendant upon production. All of the material and parts producers say the same thing: "If you automobile makers jointly require us to fill orders in which a lot, sometimes many hundreds, even thousands, of sizes are specified, you must pay more for the goods and wait longer for them. Difference in size means new setting of machinery and change of tools. Variety of production strongly tends to reduce excellence of product. If you specify unreasonable or unnecessary sizes, you are only standing in your own light." This applies to all the materials of which an automobile is made, and to the tools with which it is made.

Sentinel Trophy Won by Buick Car

Milwaukee, Wis., July 25—Going through a hard six-day run, the brake, clutch and motor tests and a rigid final technical examination without a demerit, a Model 19 Buick, entered by the Hokanson Automobile Company of Madison, Wis., and driven by Emil Hokanson, won the $1,000 *Milwaukee Sentinel* trophy, the first prize in the Wisconsin State Automobile Association's first annual reliability tour. The Pope-Hartford T model, entered and driven by Emil Estberg, of Milwaukee, was awarded second place, with a total penalty of three points. The Model G Franklin, nominated by the Franklin Auto & Supply Company, of Milwaukee, and driven by L. M. Springer, was third, with six demerits. The summary:

No.	Car	Model	Entrant	Driver	Total Penalty
8	Buick	19	Hokanson Auto Co.	Emil Hokanson	0
17	Pope-Hartf'd	T	Emil Estberg	Emil Estberg	3
21	Franklin	G	Franklin Auto and Supply Co.	L. M. Springer	6
20	Ford	T	Hickman - Lauson-Diener Co.	W. H. Diener	9
9	Buick	17	Buick Motor Co. (Wis. Branch)	Wm. Fisher	14
2	Rambler	53	Rambler Garage Co. of Milwaukee	Art Gardiner	16
22	Overland	42	Bates - Odenbrett Auto Co.	John Heber	16
18	Reo	S	Curtis Auto Co.	A. C. Thomas	19
7	Jackson	59	W. L. McEldowney	W. L. McEldowney	26
11	KisselKar	D-10	KisselKar Co.	W. C. Rice	34
10	KisselKar	D-10	KisselKar Co.	W. R. Rice	35
24	Petrel	F	Petrel M. Car Co.	G. D. Waite	38
12	KisselKar	LD-10	Johnson Service Co.	J. Marsden	42
15	Johnson	10-Spl	KisselKar Co.	Arthur Ove	52
14	Pierce-Rac'e	K	Morrison M. Car Co.	Lewis Strang	53
5	Mitchell	T	Mitchell Auto Co.	F. P. Wilkins	57
19	Corbin	18	Curtis Auto Co.	Gordon Bird	111
4	Badger	B10	Badger M. Car Co.	C. Kobersteen	142
26	Marion	Bob-Cat	Geo. Browne	Geo. Browne	204
6	Cadillac	30	Jonas Auto Co.	Aug. A. Jonas	422
16	Ohio	40A	Case Plow Works	Ross Henwood	488
3	Badger	B10	Badger M. Car Co.	Dan Arbogast	648
23	Staver-Chi.	M	Stephenson M.C. Co.	H. Monckmeier	1000
			Withdrawn end of second day.		
1	Rambler '11	64	Rambler Garage Co.	Ted Collier	2813
			Withdrawn at end of run. No final examination.		

Thirty-two Start in Cleveland "News" Reliability

Cleveland, O., July 26—At six o'clock on the dot, Monday morning Starter George Collister sent away the first of the 32 contesting cars in the Cleveland *News* Reliability run, the biggest automobile event that Cleveland has ever seen.

Nearly every car of prominence that is handled in Cleveland was entered in the run. Prominent among the starters were the famous Thomas Flyer, the hero of the round-the-world New York to Paris contest, and the historic Oldsmobile Mudlark, which carried representatives of the Cleveland newspapers.

Of the 1911 cars entering the first run of their existence are the Owen, 50 horsepower model, made by Ralph Owen, of Cleveland and driven by F. Monroe, and the Palmer-Singer, driven by Hugh Miller, the Cleveland agent, a 6-cylinder, 40 horsepower machine. Following is a list of the starters:

Car	Entrant	Driver
Oldsmobile	Olds-Oakland Co.	C. H. Winters
Studebaker "40"	Studebaker Automobile Co.	W. D. Cousins
Palmer-Singer	Hugh Miller	Hugh Miller
Buick	Cleveland br. Buick Co.	.....
E-M-F	L. J. Frisch	Frank Grace
Henry "35"	Jack Sperry	Jack Sperry
Regal	Regal Motor Sales Co.	J. C. Hipp
Hinescar	O. Alexander	O. Alexander
Gabriel	Gabriel Carriage Co.	A. S. Soper
Firestone-Columbus	Euclid Auto Co.	Harry McIntosh
Atlas	Euclid Auto Co.	Harry Kortz
Pierce-Racine	H. S. White & Co.	C. W. White
Hupmobile	J. M. Rauch	J. M. Rauch
Cutting "40"	Sterling Motor Sales Co.	J. C. Koepke
Maxwell	Maxwell-Briscoe Cl. Co.	Frank Santry
Brush	Maxwell-Briscoe Co.	D. E. McCoy
Columbia	Maxwell-Briscoe Co.	C. G. Bleasdale
Gaeth	Gaeth Auto Co.	Otto Linder
Krit	Gabriel Auto Co.	Harry Gabriel
Owen	H. R. Hoffman	Ralph Owen
National	D. E. Foote	D. E. Foote
Garford Truck	Garford Motor Truck Co.	Ralph Kinney
De Tamble	Kraus Motor Sales Co.	H. W. Orndorfer
Hudson	Hudson Motor Car Co.	Wm. McCalla
Packard	Thomas Swan	Thomas Swan
Hinescar	Woodland Motor Car Co.	F. J. Moore
Norwalk "35"	Norwalk Motor Car Co.	H. B. Olds
Oakland	Olds-Oakland Co.	Fred Krune
Stoddard-Dayton	Harry S. Moore	H. S. Moore
Overland	H. C. Knudsen	H. C. Knudsen
Chalmers-Detroit	John Stambaugh	John Stambaugh

Contest Board Declares Premier Gliddenites Are Not Stock

LIKE a bolt from the blue came the news last week that the Contest Board of the A. A. A. had reversed the ruling of the referee in the Glidden tour of 1910 and had disqualified the two Premier cars that finished in the Glidden Trophy class. One of these cars had apparently won the prize. The ruling was based upon the protest of the Chalmers Motor Company that the auxiliary oil tanks and pump equipments used by the protested cars were not stock equipment according to catalogue.

The significance of the ruling is that the Chalmers entry for the Glidden Trophy is placed first and is awarded the prize. The meeting was presided over by S. M. Butler and the text of the ruling was as follows:

"The appeal of the Chalmers Motor Company is sustained. There was no evidence adduced before the Contest Board on this appeal or before the referee or at the time the Premier entries were made or at the start of the 1910 Glidden tour to prove that the auxiliary oil tank and pump equipment was stock equipment. The Contest Board finds that this auxiliary oil tank and pump equipment was not stock equipment under the rules.

"The Premier Motor Manufacturing Company fails to comply with Rule 6 of the 1910 contest rules in not furnishing to the technical committee of the American Automobile Association, after repeated demands, from June 29 to July 21, 1910, during which period three of its members visited the Premier factory, evidence sufficient to establish the stock status of Premier cars numbers 1 and 2 entered in the 1910 national reliability tour of the American Automobile Association in respect to equipment of auxiliary oil tank and pump for injecting oil direct to the crank case.

"The decision of the referee is reversed and Premier cars numbers 1 and 2 are disqualified, and the Glidden Trophy awarded to the Chalmers Motor Company's entry No. 5."

Harold O. Smith, president of the Premier Motor Manufacturing Company, secured a preliminary order of injunction from Supreme Justice Kelly of New York against the Contest Board of the A. A. A., forbidding that body to make delivery of the Glidden Trophy to the Chalmers Motor Company.

The complaint filed on behalf of President Smith alleges that the action of the Contest Board in disqualifying the Premier entries is without jurisdiction, wrongful, illegal and a violation of the rules governing the contest.

H. O. Smith was represented in the Court proceedings by Sidney S. Gorham, of Chicago, and George C. Lay, of New York.

In commenting upon the situation, Mr. Smith said: "I have decided to test in the courts the validity of the action of the Contest Board of the American Automobile Association in reversing the decision of Referee Whiting in awarding the Glidden Trophy to me as the entrant of the Premier car No. 1, after having passed upon the protests filed with him."

At a meeting of the Contest Board of the American Automobile Association on Wednesday H. O. Smith and the Premier Motor Manufacturing Company were disqualified and rendered ineligible for competition in all contests here under the sanction of the Contest Board of the A. A. A. until further notice.

Automobile Notes from Quaker City

PHILADELPHIA, July 25—Entry blanks for the third Fairmount Park 200-mile stock chassis road race, which is now recognized as the chief motoring feature of Philadelphia, and which is rapidly attaining the distinction of being one of the chief events in the country, have been issued and as there is assurance of many notable drivers and machines, there is no doubt about its success.

The Quaker City Automobile Club will co-operate with the Philadelphia municipal authorities in conducting it. The contest this year will take place on Saturday, October 8, at 12 o'clock noon. R. E. Ross, who acted in a similar capacity last year, will be the referee, with G. Hilton Gantert and Joseph L. Kier starters. The following conditions and details of classification are announced in the entry blanks:

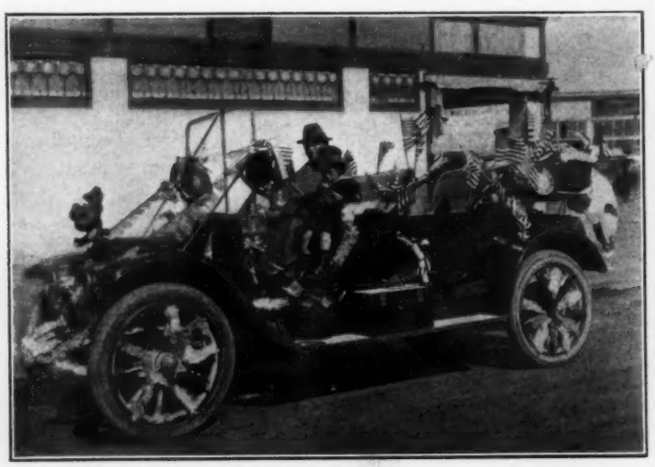
The race is open to any chassis of gasoline car which is in accordance with definition of "stock chassis" and to be governed by the following table of piston displacement and minimum chassis weights:

Division	Piston displacement in cubic inches	Minimum weight in pounds
4-B	301 to 450	2000
5-B	451 to 600	2300
6-B	601 to 750	2500

No car to compete in any class above that to which its weight entitles it. No dead weight of any character or description to be added or attached in any manner to a car as ballast. Entrance fee, $500.

Four prizes are offered for the best time for the 200 miles—first, $2,500; second, $1,250; third, $750, and fourth, $500; while at the same time there will be additional prizes for cars in each of the respective divisions.

The Philadelphia *North American* commercial vehicle reliability run from Philadelphia to Atlantic City and return August 12 and 13 is unique in that it will be the first of its kind ever held. The 26 entries in the various classes are divided as follows: Manufacturers' Division—Class A—1 1-2 tons capacity and less. Class B—Between 3001 and 5999 pounds. Class C—Three tons and over. Private Owners' Division—Class A—1 1-2 tons capacity and under. Class C—3 tons and over.



How a White gasoline party traveled to the Reno fight

New store of Maxwell-Briscoe Washington (D. C.) Company

Buicks Outclass Fields at Fort Erie Meeting

BUFFALO, July 25—Racing for two days at the Fort Erie track under the auspices of the Automobile Trade Association ended Saturday. Over 5,000 attended the final meeting.

The track was the regulation flat oval, and the competitors in the various events were hidden for part of the distance under a pall of dust. The smallness of the fields alone made it possible to try for any speed. The events generally had only two or three entrants, which robbed them of the spectacular features of large and hotly contested races. The Buick entries outclassed their rivals so as to render the majority of the events one-sided.

The Buick team had practically their own way in the majority of the contests. The summary:

FRIDAY'S EVENTS

Five miles, stock chassis, 160 cubic inches or under—

Car	Driver	Time
Herreshoff	Ned McCormick	6:14 2-5
Herreshoff	Walter Emmons	6:21 3-4

Five miles, stock chassis, 231 to 300 cubic inches—

Buick	Lou s Chevrolet	6:10
Maxwell	Ed Crane	6:22

Five miles, stock chassis, 301 to 450 cubic inches—

Buick	Louis Chevrolet	5:45
Pullman	H. Hardesty	6:09
Maxwell	Ed Crane	6:14

Ten miles, stock chassis, 451 to 600 cubic inches—

Buick	Louis Chevrolet	10:59
Buick	Arthur Chevrolet	11:20
Thomas	Ed Crane	11:30

Five miles, free-for-all, handicap—

Maxwell	Ed Crane	5:15 2-5
Herreshoff	Ned McCormick	5:30
Buick	Arthur Chevrolet	5:37
Pullman	H. Hardesty	5:42
Herreshoff	Walter Emmons	6:11

Five miles, free-for-all—

Car	Driver	Time
Buick Special 60	Louis Chevrolet	4:59 2-5
Buick	Arthur Chevrolet	5:47
Thomas	Ed Crane	6:12

SATURDAY'S EVENTS

Five miles, stock chassis, 160 cubic inches or under—

Car	Driver	Position	Time
Herreshoff	Ned McCormick	Won	6:39
Herreshoff	Walter Emmons	2	7:42

Five miles, stock chassis, 161 to 230 cubic inches—

Buick	Louis Chevrolet	Won	6:11 4-5
Maxwell	Ed Crane	2	6:15

Five miles, stock chassis, 231 to 300 cubic inches—

Buick	Louis Chevrolet	Won	5:35
Pullman	H. Hardesty	2	5:50
Maxwell	Ed Crane	3	6:19

Five miles, stock chassis, 301 to 400 cubic inches—

Buick	Arthur Chevrolet	Won	6:20 3-4
Buick	Louis Chevrolet	2	6:55

One mile exhibition—

Buick Special 60	Louis Chevrolet	:55 2-5

Ten miles, stock chassis, 451 to 600 cubic inches—

Buick	Louis Chevrolet	Won	11:50 2-5
Buick	Arthur Chevrolet	2	12:65

Five miles, stock chassis, $1,201 to $1,650—

Pullman	H. Hardesty	Won	5:09 4-5
Herreshoff	Ned McCormick	2	6:11
Herreshoff	Emmons	3	6:17
Herreshoff	Smith	4	6:52
Maxwell	Ed Crane	5	6:54

Free-for-all, five miles—

Buick	Louis Chevrolet	Won	5:08
Buick	Arthur Chevrolet	2	5:55

Five miles, free-for-all, handicap—

Herreshoff	Ned McCormick	Won	5:18
Pullman	H. Hardesty	2	5:27
Buick	Louis Chevrolet	3	5:47
Herreshoff	Emmons	4	6:17
Maxwell	Ed Crane	5	6:25
Buick	Arthur Chevrolet	6	6:33

Minneapolis State Run Has Eighteen Entries

MINNEAPOLIS, July 25—The second annual reliability run held under the auspices of the Minnesota State Automobile Association started from the St. Paul Hotel at 7.30 o'clock Friday morning, to cover 658.2 miles of fine roads to Sioux Falls and back to Minneapolis. Dr. C. E. Dutton refereed the event to Sioux Falls.

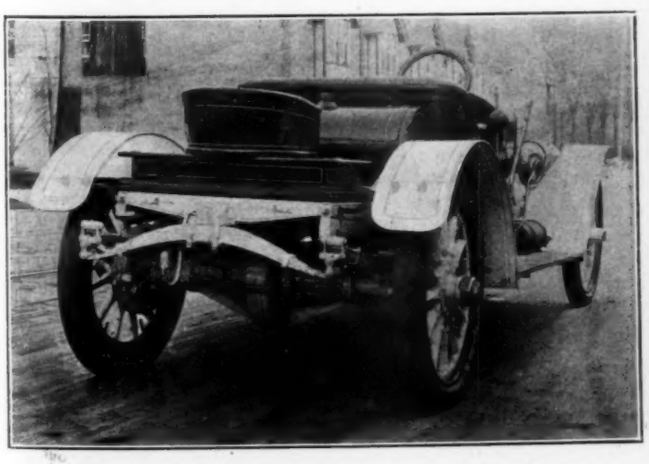
The final entry list showed 18 cars contesting and six making the run as non-contestants. The pilot car left the St. Paul Hotel at 6.15 a. m. Reuben Warner, Jr., president of the Minnesota Automobile Association, in a Pierce-Arrow car driven by Julius Huckow, was the first to follow the pilot. He started at 7.30. After him trailed the 16 other contestants and the six non-contestants, press machines, pilot car, pacemaker and two others who did not signify their intention of starting in time to be classified.

The list of entries follows:

No.	Car	Owner	Driver
1	Pierce-Arrow	Reuben Warner, Jr.	Julius Huckow
2	Stearns	Stea ns Auto Co.	J. C. Littlewood
3	Hupmobile	Electric Vehicle Co.	Fred Starr
4	Reo	Fawkes Auto Co.	C. A. Lewis
5	Staver	Heaney Auto Co.	Floyd Duis
6	Halladay	Heaney Auto Co.	O. A. Talmland
7	Cadillac	Rudstenstad	W. Rudstenstad
8	Auburn	Ranger Auto Co.	W. Y. Ranger
9	Regal	Haynes Auto Co.	Arthur La Roche
10	Cole "30"	Co e Auto Co.	T. J. Seifert
11	Cole "30"	Co e Auto Co.	W. A. Alson
12	Ford	Northwest'n Auto Co.	A. A. Hanson
13	Franklin (n.-stop)	Western Auto Co.	A. W. Clark
14	Hudson	H. L. Smith	O. E. Mart n
15	Ind. Auto Co.	Independent. Auto Co.	T. W. Shannon
16	Glide	G. L. Sylvester	C. E. Sylvester
17	Chalmers "30"	Br ctson Mfg. Co.	C. J. Gilbert
19	Cartercar	Selcey Garage, St. Paul	

Six non-contestants were Apperson, pilot car; Corbin, pacemaker; Pierce-Arrow and Studebaker, press cars, and others.

The run for Friday was from St. Paul to Owatonna, 69.2 miles, and from Owatonna to Mankato, 93 miles, making the total run for the day 162.2 miles.



Showing rear axle of Collins Axle Mfg. Co., of Pittsburg

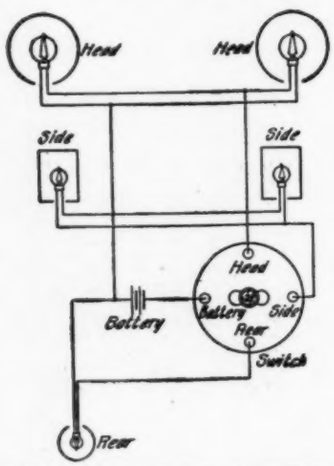
The Cohn "Special" party in a White stops at Tallac, Cal.

Accessories Occupy a Prominent Place

ELECTRIC LIGHT FOR GASOLINE CARS

THE adoption of electric lighting for gasoline cars is indicated by the safety of such a system, if for no other reason. Additional advantages to be claimed for it are, among others, "lighting up" from the driver's seat and un-blow-out-able lights. In the accompanying illustrations are shown several designs of lamps now being marketed by the National Electric Lamp Association, and a wiring diagram of a five-light system. Limousine lights and trouble lamps are also among the equipment furnished by the company. Although storage batteries furnish the most simple means of obtaining current, various generator systems have been introduced by the company for users who desire to enjoy the unstinted use of electric illumination.

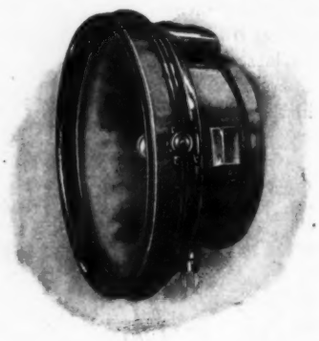
Neat electric side lamp



Five-light wiring system for automobile

A NEW FLOATLESS CARBURETER

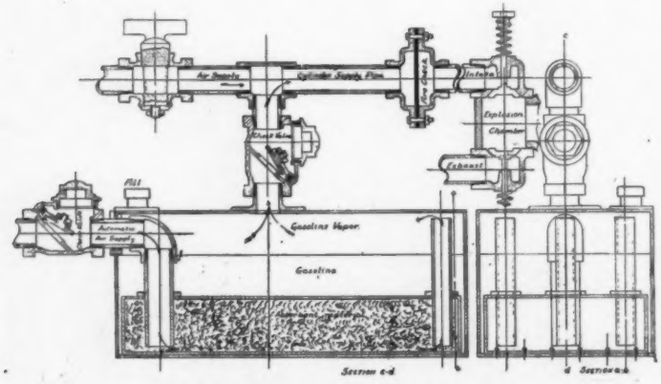
WORKING without floats and having a carbureting chamber so arranged that it does not flood or become diminished with the variation of the fuel supply are among the advantages claimed for the Steward Carbureter, which is made by L. & J. A. Steward, of Rutland, Vt. The surface principle, which obtains in this device, allows of large pipes and a consequent ample supply of mixture at high speeds. In this carbureter the circulation increases the evaporative effect by allowing the saturated vapors to more rapidly mix with the less saturated; the globules of gasoline are allowed to settle out, and the mixture is "dry"; heat is kept more uniform throughout the apparatus and contents, and sudden demands for large quantities of gas are easily met.



Electric headlight, compact and sturdy

TO BAR THIEVES AND MEDDLERS

PROTECTING one's car against the wiles of the thief and the foolishness of the meddler is an easy proposition, and not at all costly, with the Connecticut Automobile Lock, made by the Connecticut Tel. & Electric Company, of Meriden, Conn. All that is necessary for the driver, on leaving his car, is to apply the brake lever and place the lock in the adjacent notch of the segment on the release side of the same. On cars where the clutch is disengaged by the first movement of the lever before the brake is applied, the car can be locked without the brake being applied and with only the clutch disengaged, allowing of being moved about, as in a public garage. The lock is small enough to be easily carried in the vest pocket.



Sectional view of the Steward carbureter

A HANDY POCKET REPAIR TUBE

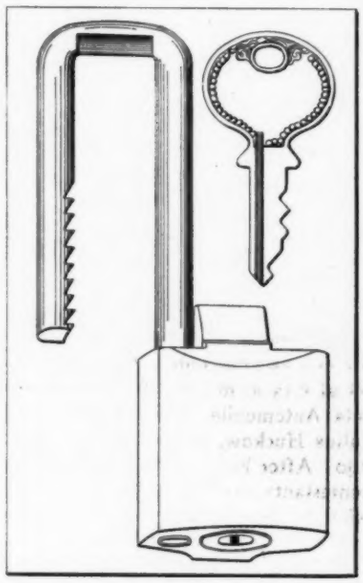
A VEST - POCKET convenience like Gray's Handy Repair Tube, made by the Standard Leather Washer Manufacturing Company, 24-26 Boudinot St., Newark, N. J., should appeal to every motorist. It costs but a trifle, and contains tire chalk, tube of cement, patches, emery cloth and other tire-repair needfuls.

These outfits come in 7-inch tubes, each 1 1-4 inches diameter.

Another side lamp

A FENDER FOR CARS DE LUXE

The New Jersey Tube Company, of Newark, N. J., has designed the Conover Bumper, which would appear to be a policy of insurance against broken radiators, lamps, etc., not to mention lawsuits resulting from accidents.



The Connecticut automobile lock

Handy vest-pocket tire repair outfit